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# THE OXFORD UNIVERSITY ARCTIC EXPEDITION, NORTH EAST LAND, 1935-36

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## JOURNEYS IN THE SPRING AND SUMMER OF 1936

(1) *Depot laying journey*

The success of the November journey to Cape Leigh Smith left only the establishment of depots in Palander and Wahlenberg Bays for the early spring. The start of the journey was delayed until the beginning of February by gales driving the sea ice out of Brandy Bay. On the 3rd of the month however Croft and Keith started out, first sledging to the central ice-cap station. Godfrey, who had been at the station over the winter, suddenly decided to join the party. This was extremely unfortunate, as conditions were cold, temperatures remaining continually around −40° F. Two of the experimental tents were taken, but they were not adequate for the severity of the conditions experienced. Rubber mattresses, also used by way of experiment, were even worse, their only apparent function being as perfect condensers of hoar-frost. The addition of the third member to the party was a further complication, especially as only one Primus stove was taken. When the frozen sleeping bags became impossible, the nights were spent huddled around the Primus stove. Faces and hands were scorched while windproofs on backs still remained stiff as boards. An unfortunate result was a badly strained heart for Godfrey, a serious loss, as he was one of the finest travellers and most efficient members of the expedition.

The route to Wahlenberg Bay from the central ice-cap station lay southwards across the depression at the head of the Lady Franklin Glacier, and climbed steadily on to and over the high east-to-west ridge. From here the ice slopes descend steeply to Wahlenberg Bay, with four glaciers, or more correctly ice valleys, heading in embayments or amphitheatres in the ridge itself. This was the country over which Sandford's party travelled during the 1924 Oxford Expedition. His description of the chaotic crevassing in

these ice valleys needs no amplification. In February of course all crevasses were safely bridged, but windless zones, filled to great depths by snow drifting off the ice cap, were discovered. These doubtless form the morasses, later turning into the snow stopes also described by Sandford. The snow, reaching depths perhaps as great as 60 or 70 feet, in the summer melts from below, forming great caverns with thin treacherous roofs.

It is probable that there is more movement in these glaciers than in any other part of North East Land. In the first place the slope to the bay is steep and there is every indication of comparatively rapid movement with frequent calving of icebergs from glacier faces. In the second place, it seems likely that the precipitation increases to the south, which would appear to be the main source of moisture-laden winds, as most of the precipitation from westerly winds must be caught by the high Spitsbergen Mountains.

A comparatively easy route was found down to the bay and the first depot laid on one of the moraines beside the glacier flowing into Bodley Bay. Wahlenberg Bay was then crossed, past the magnificent face of the Eton Glacier, with behind it its serac torn ridges, tumbling in confused array from its basin far in the East Ice. On the south side of Wahlenberg Bay several small steep glaciers flowed down from the South Ice, breaking the discontinuous lines of cliffs which flank the bay. Up one of these Ahlmann found a suitable route at the beginning of his sledging journey in 1931. Any of the others however would probably be equally good.

Palander Bay runs south-eastward from near the mouth of Wahlenberg Bay. Some 8 miles in length, its eastern side comprises undulating hills, with the ice itself never approaching the bay except in a tongue near the very head. From there a valley continues to the south coast, dividing the small separate Vega Ice on the west from the South Ice on the east. The Vega Ice however does not form the whole of the west coast of the bay, for half-way up a second valley runs westwards, dividing it from the Glittne Ice, equally small in the north. The sketch-map made by Ahlmann of the bay is extremely accurate and requires few corrections, except on its eastern side where the coast was dead ground to him on the ice cap above.

The return was made directly across Wahlenberg Bay, travelling within half a mile of the ice edge, for Hinlopen Strait itself was open. Finally across to Binney's old base and at last on to the ice cap itself. From that point the 40-mile return was made in one day's sledging.

(2) *Spring and summer survey journeys*

The north coast survey party, consisting of Dunlop Mackenzie and Wright, left the base on April 10. This was unnecessarily late, for during the previous fortnight the weather had been good and not too cold. The delay however was due to Wright and Godfrey having to work on the map of Brandy Bay. Before giving an account of the journey itself, the equipment will be discussed. The choice of this was greatly influenced by the experience of previous journeys as well as of past expeditions.

The larger of the two double pyramid tents was taken, partly as a result of the coldness of the single tents on the Wahlenberg Bay journey, and also because room was essential for computation as well as for the detailed

draughtsmanship, which in cold conditions has always to be done inside the tent. Most British Polar explorers have used these tents since the time of Jackson, and they require no description. Instead of the normal ground sheet however special canvas was used, large enough to be laid down double, thereby giving increased warmth. It was also an essential part of the sledge boat, which will be described later. Reindeer skins took the place of rubber mattresses, as these also are impracticable except for summer coastal travel, when they are excellent. For summer inland travel some sort of collapsible bed is advisable, possibly on the lines of the combined sledge bed used by Professor Ahlmann in Iceland in 1936. Sleeping-bags were double eiderdown, the outer bag being also lined with Jaeger. They were 7 feet in length, so that it was possible to get right inside and close the bag over one's head. In addition, they were so prepared that the down was unable to concentrate in lumps, leaving the remainder of the square empty. Used under all conditions on the expedition, they were always found to be excellent, being adequate in temperatures down to at least −50° F. For summer use, waterproof canvas covers could be added.

The sledge was one of the 11-foot Nansens, made by Pitman of Byfleet, but specially strengthened at the base before the journey. The crossbars were thickened and iron strips lashed to their front, to lessen the cutting effect of high lumps of ice between the runners. It would have been better had German silver or steel sheathing been taken for the runners, as the wooden ones suffered badly over bare patches of stones in the early summer. A spare pair were taken, but both had to be used until the rawhide lashings actually appeared through their undersurfaces. After that the sledge had to be carried over rough ground.

Well-tarred wooden runners give probably the finest running surface so long as the bottom of each runner is slightly convex and does not form a plane surface. The addition of sheathing undoubtedly gives a worse surface, but under conditions where bare rock as well as snow are to be met it is an advantage. In very cold conditions snow surfaces tend to give the same gritty effect as sand. It is then advisable to coat the bottom of the runner either with a mixture of flour and water or with a gruel-like porridge. This will remain for several days, provided it is coated daily with a thin film of warm water, which when frozen produces an excellent gliding surface. The general theory of sledge design however has remained static for the last twenty years. It seems obvious that an infinitely stronger and perhaps lighter sledge than either the Nansen or Greenland rigid sledge could be devised.

Eight dogs were taken, a ninth being added at the meeting between this and another party. One bitch died in whelping, and one dog was killed for reasons of food economy, but the rest were brought home healthy although thin. They had all been especially chosen, not so much for pulling power as for quiet behaviour, for it was an essential part of the plans that both men should be able to leave camp together. This is not supposed to be safe with dogs, but in actuality there was no difficulty at all. Except when there was fresh meat they were fed on dog pemmican; at the most, a pound per day, and at the least, half a pound.

Rations varied considerably, but the standard was as follows:

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| 8 ozs. pemmican. | 2 ozs. cheese. |
| 4 ozs. oats. | 2 ozs. biscuits. |
| 4 ozs. butter. | 1 oz. dried vegetables. |
| 4 ozs. sugar. | 1 oz. flour. |
| 4 ozs. chocolate. | |

Coffee and tea were also taken, coffee being far preferable, while vitamins were supplied as follows: A and D by Adexolin, B by Bemax, and C by Redoxon. Experiments indicate that bacon might alternate with oats, but otherwise the ration is not only well balanced, but extremely palatable. Butter is preferable to margarine, not because of any great difference in their food values, but merely because of taste. White sugar, and preferably lump, is essential, while as much variety ought to be introduced in vegetables and chocolate as possible. The ordinary ship's biscuits made by Spillers were always thoroughly satisfactory. A few raisins however ought also to be carried, as they are excellent for quenching thirst.

An innovation to sledging technique was the sledge boat. This had been considered by Nansen for his famous pack-ice journey, but rejected in favour of kayaks; it was used in a rough form however by Stefansson, although only for crossing small leads in calm weather. His idea was developed during winter, and a boat was finally produced which entailed an extra weight of only 15 lbs., but which could and did take one man and 500 lbs. of food and equipment in a choppy sea.

The construction was as follows: Two boxes were placed across the sledge about 3 feet from either end. Across the top of each were lashed the planks which formed the box platform of the sledge. They were about 5 feet long. To their ends were lashed the spare runners, and under and round the framework so formed was stretched the canvas mentioned above. The bow was formed of a box or ruck-sack. Rowlocks were formed of ski sticks fixed diagonally across the boat, and oars were skis. The latter were surprisingly good and are little worse than proper oars, except that they are rather unhandy in ice. They are rather short, but can easily be lengthened by lashing an ice-axe to each of their heel ends. The only extra weight was the canvas, which weighed 20 lbs., while a satisfactory ground-sheet would only have weighed 5 lbs. The other material consisted entirely of articles which were in every-day use.

In the autumn, when this journey was planned, it was realized that depots of food would be necessary, for it would last fifteen weeks, and with eight dogs and one sledge it would be impossible to carry enough food for more than about five weeks. Therefore, as has been described, depots were laid at Cape Leigh Smith and Wahlenberg and Palander Bays, each containing about five weeks' food for men and dogs. There was no reliance on hunting, which was fortunate, for owing to an unforeseen accident the only rifle was rendered useless by warping of the barrel, and there would have been no alternative but an ignominious return. Unfortunately these depots had been planned so that not more than ten weeks could be spent on the north coast, as it had been expected that the survey would be finished in six or seven.

That it was not so was due partly to there being more ice-free land than

*Nansen sledge*

*The sledge afloat*

*The sledge used as protection against summer rain*

*Looking east from the West Ice across the head of Rijps Bay, with the East Ice in the distance*

*Rijps Peninsula. Gorge exaggerated by snow drifts*

previous reports had suggested, and partly to the bad weather in May and June. All went well until the beginning of May, when the temperature, which had been steady at about −10°, went up with a rush to above freezing, accompanied by mist and low clouds. For the next two months the weather alternated between warm spells accompanied only too often by these low clouds, and cold windy spells when snow was falling most of the time. From April 28 till June 4 surveying was possible on only seven days—one day in five. As a result the party spent most of its time in the tent, and at the end of this time they were still working on the west side of Dove Bay, having mapped only about 150 square miles in seven weeks.

On the east side of the Rijps Peninsula, while walking round the coast of a small bay, Mackenzie saw a cairn some way from the shore. Approaching it he found a camp site with several boxes and old tins littered about. In one of the boxes there were some Italian documents, wrappings from chocolate and dried bread, and quantities of balloon cloth which had been treated with some rubber solution. These were all collected, and a sketch and full details taken of the camp site. Clearly it must have belonged either to one of the two rescue parties who sledged along this coast in 1928 in search of Nobile, or to some unknown survivors who had managed to escape from the after part of the airship. Hilmar Nois, who was a member of one of these rescue parties, was met later at the Norwegian coal mine in Spitsbergen and denied that the relics were in any way connected with his party. He also declared that as far as he knew the second party did not possess among their equipment any of the relics found. The matter is now being followed up. Possibly it may lead to proof that there were survivors from the after-gondola of the *Italia*, which Nobile saw drifting away to the north-east immediately after the crash. On the other hand, it seems much more reasonable to think that the relics belonged to the second of the rescue parties.

An unfortunate result of the bad weather was that precious time had to be wasted in fetching the depots from Wahlenberg and Palander Bays, about 70 miles to the south-west. This event had been postponed as long as possible by cutting down the consumption of man and dog food, and also by fetching the Cape Leigh Smith depot. This was only 50 or 60 miles distant over ice cap the whole way, and Wright fetched it alone during the middle of May, taking sledge, dogs, and tent, while Mackenzie surveyed from an improvised shelter, using a driftwood fire. He showed great energy during the three days that Wright was away, and deserved more success, for he twice climbed mountains over 1500 feet high, to be balked by a sudden snowstorm on the summit.

The journey to Palander Bay, starting on June 3, was longer as well as later in the season, so they decided that both men had better go, owing to the complications of rotten ice and heavy going. It took nine days, most of which turned out fine, two of them being spent in looking for the second depot at the head of Wahlenberg Bay. Neither Wright nor Mackenzie had been on the party which had laid it, and owing to a misunderstanding they never looked in the right place, and so had to return without it. During this journey however they shot two seals and a bear, the only one while they were away from the base, but were unable to take all the meat with them.

Continuing to live on reduced rations of about 20 ozs. per day, occasionally helped by birds, they worked southwards from Dove Bay, across Rijps Bay, down the east side of the West Ice, and so home from its south-east corner. Progress was slow, for the weather became bad again until July, the snow thawing and the bay ice becoming unsafe. This had prevented their going any farther east, because oddly enough, though temperatures are apparently lower in the east, the bay ice appears to break up there earlier. The Dove Bay ice became unsafe on June 15, in Rijps Bay the ice was good though not complete on June 27, and the party was the last to cross the Brandy Bay ice on July 9.

The Rijps Peninsula is a vast tongue-shaped block of land, much faulted and almost entirely ice free. It is some 20 miles long by 7 broad, and contains the highest land in the island. Its rock structure is extremely complicated, red and grey granites, and mica schists being found in close contact with different beds of Hekla Hoek series. Both coasts are formed by a line of cliffs, broken only twice in the west and several times in the east by inlets. The height of the cliffs is generally between 100 and 300 metres, but the central part of the peninsula rarely exceeds 200 metres in height. This synclinal appearance is clearly marked, but it is also a characteristic of the Laponia Peninsula, with its granite headlands steadily rising to their points, and radiating from a central area of lowlands.

Vegetation is scanty and the greater part of the region is covered by granite boulders, many of which have evidently been rounded by ice. There are few reindeer, and bird life, even in summer, is negligible except for occasional cliff colonies.

The land features are characteristic: blocks of hills cut with wide valleys between. In the north the hills become higher and steeper and the massif situated north-east of the head of Zordragger Bay contains the two highest peaks in North East Land, one 546 metres and the other 607 metres. Despite the height of this part of the land it is nevertheless possible to cross in many places from east to west without rising above 200 metres. These valleys, which so simplify travel, are more typical of a normal erosion surface than a glaciated one. The whole area indeed is completely lacking in the larger features of glacial erosion, although equally well there is plenty of evidence that ice has covered most of the land. A certain amount of rounding must naturally have been done by solifluction, but nevertheless there is the distinct impression that little erosion has been carried out by the ice. It therefore seems evident that the main land features were determined by subaerial erosion. Judging from the condition of the present ice-sheet it may be that the ice was always stagnant, and therefore had little determining effect upon the features of the country. Interesting too are the deep gorges cut through the rock, with at their bottoms, perhaps 100 feet or more in depth, tiny streams quite incapable of such corrasion. This would seem to indicate a period of catastrophic ice retreat, when torrents poured down, driving their way to the coast.

The peninsula is almost entirely ice free, although it is evident that it must have been covered by an extension from the East Ice. A few isolated remnants of the ice cap still remain, the largest situated between the head of Dove Bay

and that of Rijps Bay, with several smaller ones on the mountains above Zordragger Bay, and on the east side of the Platen Peninsula. The thickness of these ice-sheets is invariably small. Some of course still cover valleys, but it would probably be correct to say that they rarely exceed 40 or 50 metres in thickness. Their very existence and conditions around their edges are interesting, for they give added proof of this characteristic of North East Land ice caps, namely, of a stagnant ice-sheet melting away in situ. The usual relics of retreat, such as end moraines, are practically non-existent, and this holds good, not only for the Rijps Peninsula, but for the greater part of the rest of the country.

The crossing of Rijps Bay on the return was slightly difficult. Firm ice extended to within half a mile of the western shore, but when they reached the edge a strong wind prevented their launching the sledge boat. There was no alternative but to wait until the following morning, when Wright succeeded in taking across all the stores. As he returned however the wind began to rise, and when he once more reached Mackenzie the ice edge was rapidly disintegrating. Suddenly the floe on which they stood broke, drifting out to sea; jumping into the boat they found it impossible to row, as they had to concentrate all their energies on bailing and keeping afloat. Eventually however they and the floe on which the dogs still stood were drifted to the head of the bay, and finally into the shore.

They had no adventures after this, and returned to the base on July 9, having surveyed the Rijps Valley *en route*. They had had to relay or portage most of the time after leaving Dove Bay on June 15, and thus had taken twenty-four days to cover a distance which would only require three days in spring.

The results of this journey were not very great, so Wright and Hamilton determined to try and finish the north coast, working on a different plan. Only five weeks remained before the ship was expected. These were the worst five weeks of the year, when the thaw might be expected to prevent ice-cap travel. Profiting from the experience of the 1924 Oxford Expedition the equipment was made as light as possible. Some of the details may be of interest.

The sledge boat was intended to serve as a tent, and only one reindeer skin and single sleeping-bags were taken. As a result the weight of all unconsumable articles was cut down to less than 200 lbs., including survey instruments and the sledge. There was no economy on food, for the Wahlenberg Bay depot was picked up. Even so, the complete sledge load never exceeded 600 lbs., which in fact made the journey possible.

Conditions could not have been so bad as those experienced by the 1924 expedition, for the weather was fine during practically the whole journey. The plan was to reach the eastern end of the north coast and then to work westward along it, travelling along the ice cap by sledge and walking down to the trig. points, which were never more than 10 miles off. The sledge boat was actually never used. With the help of Mackenzie, Croft and Whatman, all the necessary equipment was carried in one day from the base to the advance base, as the state of the bay ice made neither sledging nor the use of a boat possible.

Rijps Valley, almost entirely free of snow, was crossed by a mixture of sledging over the smooth parts and portaging over the rough. The former method was used too much on the outward journey, one sledge runner becoming worn through and eventually breaking. It was successfully spliced however and the repair lasted for the rest of the journey. The system employed was ingenious. A narrow slit was cut out of the bottom of the runner and the two pieces brought together, the overlaps being secured by screws. Along the grooves on either side of the upright two long wooden splints were placed, which were then securely lashed into position. The whole was covered by tin from an old chocolate box, nailed into position in such a way that the surface of the bottom of the runner was once again perfectly smooth. In principle it was extremely simple, and in practice equally successful, for the sledge gave no further trouble throughout the rest of the journey over a distance of between 200 and 300 miles.

From the red granite hills at the head of Rijps Bay the Rijps Valley gradually rises to the watershed 12 miles farther south. Flat beach-like moraines have here run together, to form an undulating plain rising at the sides, where the moraines separate and grow smaller until the ice covers everything. The East Ice descends very much more steeply than the West, but occasional crags break through its surface. At the watershed whale-backed hills begin to rise to the south, forming three valleys, all of which fork in a general change of direction to the south-west. The ground steadily lowers until Wahlenberg Bay itself is reached. The Rijps Valley in fact is more an undulating plain than a true valley. The two ice sheets have probably melted away rather than retreated catastrophically. Near the watershed is the single remnant of the old ice covering, a small ice cap, which although uncrevassed has all the characteristics of larger members of its kind.

The Oxford Peninsula, at the head of Wahlenberg Bay between the West Ice and the Eton Glacier, consists of undulating country, rising steadily to the three valleys which lead up to the watershed. It is formed mainly of different series of the Hekla Hoek beds with granites outcropping near the edge of the East Ice itself. On its southern side is a large lagoon flanking the dead ice wall which continues westwards into the shattered face of the Eton Glacier. The peninsula, with its moss-covered slopes and frequent signs of reindeer as well as tracks of bears, is one of the most fertile parts of North East Land. In 1924 a swan was shot on one of its lakes. Wright and Hamilton saw no swans, but they sighted a turnstone and phalarope, as well as a large flock of geese on the lagoon, the two first being the most interesting finds of this nature except for the discovery of a snowy owl in the Rijps Peninsula and the arrival of a mallard at the base in April.

The route to Cape Leigh Smith led across the northern slopes of the East Ice, and a certain amount of trouble was experienced in crossing glaciers, streams and morasses. The lightly laden sledge however saved much difficulty. On one occasion, when camped low down on a glacier, they felt a firnstoss or icequake; probably the first time this has been felt so near the edge of an ice cap.

After arrival at Rasch Island, which lies opposite the limit of ice-free land on the north coast, they began to return westwards. They proposed

to travel along the edge of the ice cap to Dove Bay and establish standing camps near the land, so that Wright might be as close to his trig. points as possible. On his previous journey to Cape Leigh Smith he had been able to plan positions for these, thereby saving considerable time in the actual survey. In Dove Bay were the easternmost points which he had been able to fix with Mackenzie; these he hoped he would be able to join to his present triangulation, thereby completing it from Brandy Bay to Cape Leigh Smith. There was clearly no time to complete the plane-tabling of the coast from Dove Bay eastwards, so the coast and ice edge were put in by short base methods assisted by rounds of photographs.

Taking advantage of a fortnight's perfect weather, they succeeded in completing their plan, and thereby finishing the survey of the north coast on August 7. Between Dove Bay and Rasch Island the ice edge runs inland from the coast, only twice reaching the sea. The most eastern part is that best shown on Ahlmann's map, which is remarkably accurate, and the only general error in which is the smallness of the bays. The coast actually consists of a series of headlands, separated by the bays 3 or 4 miles deep, at the heads of which the ice edge either meets or approaches the sea. As in the Rijps Peninsula, the land rises towards the headlands, while behind them it is lower and undulating, consisting of granites and granitic gneisses, as reported by Nordenskiöld. There is mile upon mile of boulders, utterly barren, and apparently recently freed from ice. It gave an impression of desolation, with heaps of sand as if at random, stones perched upon boulders, and streams running down riotously into the lakes. Rivers occasionally cut their way through shingled terraces to the sea, but they were never large enough to give any difficulty in crossing.

Off the eastern part of the coast there are a number of islands, but only one of these is of any size. This one corresponds so closely to Nordenskiöld's description of Rasch Island that there is little doubt that it is the same. Tandberg's description of this part of the coast is difficult to reconcile, for there are no other high islands, such as those named "Esmark" and "Tandberg" Islands. The others are all low and flat, never exceeding 10 metres in height. It is possible of course that his mistake is due to taking headlands for islands.

From Cape Brunn the coast becomes more intricate. The two large Reps Islands lie a few miles north-east of Dove Bay. They are little different from the rest of the coast, the outer one reaching a height of over 200 metres, and although descending gently to the east, ends in a steep cliff on the west. The inner is lower but three times the size, consisting of an undulating plateau. The peninsula to the south very nearly forms a third island, being joined to the true mainland by a narrow neck.

The area to the south of Finn Malmgren Bay is much more ice free than had been previously thought. The ice edge makes a big bend to the south, and there is thus left a land area some 15 miles square. This is the last large area of land to the east of Cape Platen, the ice cap approaching nearer the sea until the ice cliffs begin opposite Rasch Island. To the west however, except for the one single glacier flowing from the East Ice into Dove Bay, the land becomes increasingly exposed.

The ice cap behind appears to be thin and inactive, lying utterly stagnant except where it slowly moves down its glacier courses. Ridge succeeds ridge with hollows between. Even the glaciers are probably almost inactive, for they rarely calve and they are comparatively little crevassed. In fact, exactly as farther west, there is probably little retreat; the ice sheet is melting away in situ, perhaps eventually to leave isolated caps such as those on the Platen Peninsula.

The most characteristic feature of the ice edge however resembles the unbroken lines of frontal moraines. This at first sight would seem to militate against the theory of stagnant melting away in situ, but it is probable that they are not real moraines at all. It is more likely that in such places the ice edge ends on high ground, which fronts the coastal plains in a scarp. Snow drifts collect along its foot, giving an erroneous impression of ice. While the ice actually covers the scarp it is possible that, stagnant as it is, materials are brought forward from the subglacial scarp edge to form moraine in the sense suggested by Hobbs, as occurs in certain cases in Greenland.

The return journey to the base was without incident. The crossing of the Rijps Valley was accomplished at its narrowest point, where the East Ice is only divided from the West Ice by some 5 or 6 miles. The ice edge here however is different from its description on Ahlmann's map. An incidental and fortunate result of the crossing was that the exact route to and from Cape Leigh Smith taken by the November party was discovered. As their final camp site at Cape Leigh Smith had previously been found, the two traverses made on this journey can therefore be plotted with some accuracy. Wright and Hamilton reached the base once again on August 18, two days before the ship arrived.

(3) *Northern journey*

Croft and Glen had hoped to be able to make a journey northwards over the sea ice to as high a latitude as possible, in order to study weather conditions relative to those in North East Land. It was intended also that observations should be carried out on the drift of the ice and soundings were to be taken at different points.

Practical difficulties however were considerable. Financial restrictions prevented money being diverted to this from other and more certain objects of research. The scientific equipment had therefore to be of the simplest. For a journey of this kind it is almost essential that this should not be so, such items as lightweight echo sounders like the Behm being as vital as they are expensive. The number of dogs too was limited, and the requirements of the survey journey finally left only one team of ten available.

Sea-ice conditions were chaotic, although possibly not more so than usual. Nevertheless this factor finally sealed the fate of the journey, for one of the two sledges was broken, and retreat had to be made back to North East Land, when only 50 miles or so from land. The return was so slow that not more than 5 or 6 miles could be sledged per day, but at last, early in May, they were once more at the base.

The journey had been a complete failure, both technically and scientifically. Nevertheless it may have certain significance. The exploration of the Polar

Basin is probably the next major problem of arctic research; it must also be one fraught with more difficulties than perhaps any other. To be satisfactorily attacked a large-scale expedition will be necessary in which aircraft must play a considerable part. Units travelling over the sea ice will probably also be essential, and the question in that case must arise whether mechanized transport can ever compete with dog sledging. The experience of Byrd and Rymill in the Antarctic during their recent expeditions has indicated that the husky even to-day is the most important factor in Polar exploration. In the design of sledges however, as has been previously indicated, it is probable that a considerable advance is possible if use be made of modern knowledge of structural engineering.

(4) *Journey around North East Land*

After the northern journey weather conditions were such that Croft and Glen judged it probable that the survey of the north coast would have been so delayed that the east and south coasts would be unmapped. It was essential that they should be back by the middle of June in order to evacuate the central ice-cap station, and also so that Glen could complete the mapping of the rock structure of the north coast between Extreme Hoek and Rijps Bay. It was therefore impossible that they should be able to work on anything like the accuracy of the north coast survey, but by making use of the fixed points on the east and south coasts they ought to be able to complete a reconnaissance map which would be a great advance on any previous knowledge. In addition, by taking heights from a battery of three aneroids every mile, and by fixing these positions by sights to fixed points, they should be able to complete traverses of great accuracy. So many crossings of the ice cap had been made and were still planned that the contours both of the West and East Ice should, as a result, be delineated with little possible error. Finally, observations on the elevation of the firn line had still to be completed at different points around North East Land.

In four days' travelling from the base they reached the northern of the two areas of bare land which exist a few miles to the south of Cape Leigh Smith. Both these were first reported by Commander Worsley in 1927, as well as the existence of a group of eight small islands 2 miles seawards from the southern land. All the exposed rock consists of granite, but there are also raised beach-like moraines to a height of 70 metres, in which shell fragments were found.

Vegetation was practically non-existent, but although it was only May, eiderduck were present in large numbers in the open water between the islands. An occasional snow bunting was also seen, as well as a few kittiwakes and fulmars. Bay ice still covered the small inlets, also extending in an unbroken sheet out to the islands. Elsewhere however the sea was open except to the north of Great Island, where heavy pack stretched to the horizon. Giles White Island was vaguely visible and apparently free from sea ice as well, as was King Karls Land to the south. Ice conditions in fact were altogether amazing for the time of year.

A nine days' blizzard delayed progress at the northern land, after which the journey was continued down the east coast. Before 1924 it was believed that this consisted of continuous ice cliffs, but Binney discovered a small area

of bare rock, half-way down, which he named Isis Point. The discoveries of Commander Worsley showed the presence of the two areas of bare rock farther north, between the southern of which and Isis Point there is a further exposure, to which a moraine winds down from a mile inland. South of Isis Point was the rumoured position of Nordenskiöld Fjord. This in fact does not exist. To the north of Ice Point the ice cliffs do certainly run in to form a circular bay, but its depth cannot be more than 2 miles, and there is no inlet at its head. There is however a vast ice basin, crevassed in every direction and shattered into confusion. As Nordenskiöld only saw his fjord through mist, it may well be that it was this basin which he discovered, and not, as Professor Ahlmann has suggested, that of the Eton Glacier. This is mentioned merely as a possibility and not with any intention of suggesting that Ahlmann's assumption is necessarily incorrect. The detailed investigations which he has made into Nordenskiöld's route demand that the utmost consideration be given his decision. At the time he made it however the existence of this second basin was unknown.

On June 10 they reached the south coast, sledging down to the most easterly point of land, where the ice cap begins its continuous line of cliffs to Isis Point. Towards Ulve Bay the ice cap descended over several well-marked ridges across which very straight parallel crevasses ran in a south-east–north-west direction. The moraines flanking the ice boundary at the east of Ulve Bay are divided from the land itself by a river valley, and from there westwards to Cape Torell extends a dull expanse of ice-free land. In the eastern part a low scarp rises from the flat shoreland, very gently increasing in height inland until finally swamped by the ice. Farther west the scarp turns to the north-west and its slopes become more gentle. The ice edge goes correspondingly farther from the sea, reaching a maximum distance of about 7 miles. Half way between the Black Mountains and East Ulve Bay, a succession of raised beaches becomes more evident, continuing in one part to the ice edge itself. A lobe of ice flows down to near the sea to the east of the Black Mountains, petering out on the low coastal flats. It has presumably been mistaken for the glacier on the western side of the Black Mountains, which possesses a distinct but fairly narrow face, although it is an offshoot of the Erica Valley iceflow. This latter would seem to be the true Rosenthal Glacier, and not the decadent ice lobe to the east.

The Black Mountains consist of three distinct dolerite massifs: the northern forming part of the whole ridge, which runs southwards from at least 3 miles up the south-east side of Erica Valley, the southern being separated from the northern by an east-to-west through valley, and the most western being slightly lower and just over 200 metres in height. No trace of dolerite was seen to the east of the Black Mountains.

Long low points run seawards at intervals along the coast with lagoons behind them, flanked by heaped storm beaches. Everywhere are signs of oscillations in level, an unbroken succession of beaches extending in one place a distance of almost 6 miles inland.

An approximate theodolite triangulation was carried along this whole stretch of coast, finally being tied on to Cape Torell. After completion of this, return was made directly to the base, a distance of between 50 and

*On the pack ice east of the Seven Islands*

*The Spitsbergen Mountains*

60 miles being covered on the final day's travel. The full objects of the journey were achieved, a reconnaissance survey being completed of both the east and south coasts. The traverses also gave most valuable results, heightened by the fact that as far as possible travel was limited to those days on which visibility was good. The glaciological results bore out the observations of Professor Ahlmann as to variations in the elevation of the firn line. The sea-ice conditions recorded however were most interesting and equally unexpected.

(5) *Other journeys*

In July and August a journey was made by Bengtssen and Glen along the western half of the north coast to complete the mapping of the rock structure. The results obtained in this journey have not yet been fully worked out.

Travel was by means both of sledge and boat, one of the sledge boats being carried. This being lost in an off-shore storm, a second boat was constructed out of two Li-lo mattresses and planks from an old hut. In it they were able to travel some 80 miles, on one occasion taking six dogs as well as some 300 lbs. of equipment. As a result of the perfect weather the rock structure was finally mapped as far as the East Ice; the North Rijps Peninsula however remained unexamined in detail.

(6) *Surveys round the base*

From the beginning of April till the end of July the survey of the area round the base was being carried out in various ways and by various people. Godfrey and Wright began by establishing three trig. points at the mouth of the bay, and including the northern ice-cap station in the subsequent network. After this the mapping was continued solely by plane table, resecting from these points and from Mount Celsius in the south-west. At first the work was spasmodic; Hamilton and Whatman carried out an occasional long day's work from the base when their duties allowed it, but when Glen and Croft returned from their ice-cap traverse a proper survey scheme was organized. Small food depots were laid near Franklin Bay and east of Brandy Bay, and Moss and Croft started work near the former. Croft went back to the base in order to prepare for his Spitsbergen journey, and Mackenzie took his place. Working round the head of Brandy Bay he and Moss reached the base at the end of July.

By this means the ice-cap edge and the land between it and the sea were mapped on a scale of 1/100,000, from Extreme Hoek to Mount Celsius. There were several interesting discoveries. The glacier at the head of Franklin Bay had retreated 4 miles, and a separate ice cap was found to the south of it. A number of small lakes were found to exist in the hilly granite isthmus between Extreme, Brandy, and Lindhagen Bays. The completed map was very different from the rough sketches hitherto compiled.

## The biological station at Murchison Bay

No biologist can visit North East Land without being struck immediately by the great contrast in animal life between this island and the rest of Spitsbergen. Except for the western part it seems to lie outside the influence of the Gulf Stream, giving it a more severe winter and delaying the break up of

*Lomme Bay Glacier*

the ice. It is the absence of any real summer however which is the most important factor governing animal life. Rarely is the sea-level temperature above 40° F. even in July and August, heavy snowfalls are liable to occur at any time, and throughout the year strong winds are the rule. With such a climate it is scarcely surprising that of the few birds spending the summer months in North East Land only a very small percentage breed. Plant life is correspondingly scanty. With even one warm month in the year the breeding population of birds and the abundance of plants would be enormously increased. Keith was to have ample opportunity in the summer of 1936 of watching the way in which the bad weather prevented birds of many species from nesting.

During the boat journey along the north coast in August and September 1935 he was able to observe the birds of this comparatively favoured part of North East Land. Apart from the colonies of kittiwake (*Rissa t. tridactyla*) and fulmar (*Fulmarus g. glacialis*) on Cape Loven, and of arctic terns (*Sterna macrura*) on Scoresby Island however there was little else. Scattered pairs of Mandt's guillemots (*Uria grylla mandtii*) were nesting along the coast, and a few broods of young eider (*Somateria mollissima borealis*) off Scoresby Island; inland an occasional purple sandpiper (*Erolia m. maritima*) or snow bunting (*Plectrophenax n. nivalis*) might be encountered, or sometimes a solitary arctic skua (*Stercorarius parasiticus*). Although it was late in the season it was still easy to tell that large numbers of the birds—with the probable exception of the cliff communities—had not nested at all.

These observations and his work in the following summer convinced him that this large non-breeding population of nearly all North East Land species is normal. It is so large in fact that it is quite impossible for the status of each species to be maintained from year to year by the birds which do actually breed. Every summer therefore many birds must come to North East Land which were bred elsewhere, and which have been forced to occupy this uninviting marginal territory by the pressure of numbers in the more favoured parts of their breeding range.

The autumn migration begins to become apparent in mid-August. In early September large flocks of kittiwake, fulmars, and Mandt's guillemots had begun to collect in the bays preparing to leave. Snow buntings too were assembling in large numbers. By October there were hardly any birds left, but in the middle of November—when it was already twilight at noon—two eiders were found swimming about in the porridge ice in Brandy Bay. They became the Christmas dinner at the base.

As the base hut lay beneath one of the largest colonies of fulmars and Mandt's guillemots in North East Land, we had every opportunity to study the arrival of these birds in the spring. The first bird, a solitary fulmar, appeared in the middle of February before the sun had risen above the horizon. But this must have been an erratic individual, and the real arrival of the birds did not begin till March 10, when four Mandt's guillemots were seen at the cliffs. After this these birds began to appear regularly. At first they arrived at the cliffs in the early hours of the morning and only stayed a short time each day. As the month progressed they arrived earlier and stayed longer, but until the end of April the guillemots still left the cliffs in the afternoons.

They would arrive about 11 p.m. and leave about noon, dividing their time between the cliffs and leads of open water to the north-west. The fulmars however did not share this curious habit, and after they had begun to arrive in early April they were to be seen at the cliffs throughout the day.

Brandy Bay seemed to offer few opportunities for biological work. During the first summer it had appeared a barren area with few birds save for those of the cliff colonies. It was therefore arranged that Keith should spend the summer of 1936 in Murchison Bay, which lay 40 or 50 miles farther south. This bay was dotted with many small islands, and was surrounded by large areas of ice-free land; it had several colonies of cliff-nesting birds on its shores and in fact seemed to be the best place in North East Land in which to carry out the intensive biological work he had in mind. It had the additional advantage of being suitably situated to form a base for the survey of the west coast, and therefore Godfrey decided to make his headquarters with him. They proposed spending twelve weeks away from the base, and for this a considerable amount of food and equipment was needed, which was taken to Murchison Bay in two journeys in March. During the second of these the remains of a small hut was found on one of the islands in the bay. Godfrey and he hoped it would be possible to transport this to a suitable place and re-erect it, as they both decided that a hut, however small and ramshackle, was preferable to a tent for their base.

They left Brandy Bay in May, manhauling the final load as the dogs were away on the summer journeys. Whatman came to assist as the load was impossible for two men; it was heavy enough even when there were three, though they had made every effort to keep the weights as low as possible. They reached Murchison Bay in four uneventful days, having had to relay the load across the Wargentin Peninsula. On reaching the bay however troubles began, as arrival coincided with a warm spell of weather. This first made the bay ice very sticky, greatly increasing the effort necessary to move the sledge, and finally caused the snow on top of the ice partially to melt, so that they were eventually trying to pull the sledge through ice-cold slush 18 inches or more in depth. This delayed the comparatively simple matter of digging out the hut, taking it to pieces, and transporting it in sections to a promontory on South Russian Island, which they had chosen for the base.

At first life was somewhat monotonous. The continual bad weather was worse than had been expected, and delayed the arrival of the birds till long after it had been hoped they would appear. At this time all that could be done was to examine the country round the bay, taking the meteorological readings, and trying to keep the meat rack stocked. This last they found was a whole-time occupation, and even then was often enough an impossibility. It had been impracticable to bring any meat from the base, as its weight made its transport out of the question, and they had therefore to rely on a gun and a small rifle. Until mid-June the difficulty of procuring meat was one of their main preoccupations.

At this time a bear and two cubs were hunting in the bay and seemed to have a particular attachment for the promontory on which the hut had been erected. Several times she spent the night curled up in a snowdrift on the shore 60 yards away, and she and the cubs would sometimes spend days

resting and playing together within 100 yards or so of the hut. Murchison Bay indeed was much frequented by bears. On arrival it was found that the dump laid by the sledge parties had been discovered by bears, and some of the boxes had been broken open and the contents scattered. During periods of calm weather in the winter the bears travel south from the pack, where they have spent the summer. Cubs are born in February in holes which the females excavate in deep snowdrifts, and they spend the succeeding summer months in this neighbourhood before moving north with the break up of the winter ice.

Meanwhile the birds had begun to arrive. At the beginning of May the first eider appeared. Their numbers rapidly increased and they were constantly to be seen swimming idly or resting on the edge of the pools which were now appearing in the ice. Towards the end of the month the purple sandpipers began to arrive, and at the beginning of June the red-throated divers (*Colymbus stellatus*), terns, and grey phalarope (*Phalaropus fulicarius jourdaini*). Throughout June the weather was appalling. Snow and rain-storms with strong winds and mist seemed almost continuous, and it was only a few birds that had begun to nest before July.

Early on it became apparent that 1936 was going to be a "non-breeding year." This non-breeding is a feature of arctic ornithology which has of late been arousing considerable interest, but for the cause of which there is as yet no generally accepted theory. Much work on the subject has been carried out in Greenland and Spitsbergen, and it is now well established that these non-breeding years occur in an almost regular cycle of four years (though on some occasions the interval seems to have been three years); and although there is some variation in the species concerned, it is in almost all cases the ducks and geese which are most affected. Usually the divers had been found to be similarly affected, but in North East Land these were nesting in normal numbers, and this periodical non-breeding was restricted to the eiders and Brent geese (*Branta bernicla hrotah*). Many theories have been put forward, but none has yet been found with universal application. The one most generally held lays the cause on the climate; it is often suggested that poor falls of snow the previous winter, followed by a late breaking up of the winter ice, might prevent the birds from nesting. There was no reason to suppose however that the snowfall of the winter 1935–36 was any less than usual, and the bay ice certainly went out in 1936 considerably earlier than in the previous year. Also if this were the explanation it might be expected that the birds which do nest would do so later than in a normal year, and this is not the case. Until it can be shown that there is some periodic variation at present unknown in their food supply, climatic conditions appear to be the only variable factor in the birds' environment, and would seem to be of necessity connected with the non-breeding. Nevertheless there is no regular climatic cycle of four years, such as there is in the occurrence of these non-breeding years. In all cases where this phenomenon has been observed, the waders and passerines have been found nesting normally, and it is impossible to suppose some general factor affecting reproduction throughout the arctic as the cause of these years.

During the nesting period of the ducks Keith examined the gonads of many

eiders, and found that in practically all cases the testes of the drakes were fully developed, but that the ovary of nearly every duck was scarcely enlarged at all. It would be unwise to argue from this one case; but if a similar result is found another year, the cause of these non-breeding years will then have to be sought in some factor which affects the sexual development of the ducks and not of the drakes.

By July Keith and Godfrey were finding it easy to keep themselves supplied with meat, for in addition to the many birds which were now in the bay, the seals were basking on the ice in great numbers. As the sun rises the seals begin to sleep more and more, and whereas before they slid into their holes at the slightest hint of danger, it was now possible to approach them quite closely if the hunter only moved when the seal was actually sleeping. It was possible to get within gunshot, and on one occasion, after a specially careful stalk, a seal was caught by hand.

The reindeer offers such a ridiculously accessible food supply that the Norwegian Government have found it necessary to afford it protection in an attempt to save the North East Land form from complete extinction. There were several in Rijps Bay, in the ice-free valleys on the north coast, near the base, on the Wargentin Peninsula, and frequently at Murchison Bay, and in all cases they showed a lamentable lack of respect for man. For this reason they are slaughtered mercilessly by the sealers who visit these shores every summer, and despite the legislation it can only be a matter of a few decades before they are exterminated.

The reindeer and the fox are the only mammals resident in North East Land, and both must have a bitterly hard struggle for existence. In fact it is hard to see what there is for the foxes to live on, apart from scanty bear and reindeer droppings. In a non-breeding year the foxes are virtually deprived of the young eiders and eggs, which must normally form a substantial part of their summer diet.

Apart from the ornithology the biological work consisted merely of making as complete collections as possible of the plants and insects. It is as yet impossible to give an account of these collections (which are deposited in the British Museum (Natural History), and Hope Department, Oxford), but it can be said at once that in both these fields the list of species found in North East Land is incredibly small. Even West Spitsbergen appears to have a flora and fauna of tropical luxuriance when compared with North East Land. In dolomitic areas such as the islands and surrounding country of Murchison Bay, and in other areas such as Low Island, the paucity of plant and animal life almost defies description. It is possible to walk over literally miles of country without seeing more than an occasional clump of purple saxifrage or arctic poppy, and where the only bird would be a solitary arctic skua passing overhead. The only places where close plant communities are found are where there has been manuring in some form or another. The most noticeable of these are below bird cliffs where there may even be a carpet of vegetation similar to West Spitsbergen. These green patches, such as those by the base and below Floraberget in Murchison Bay, are clearly visible from many miles away, standing out in marked contrast to the browns and blacks of the bare rock elsewhere. On a smaller scale more luxuriant plant growth is found round

disused eiders' nests, near the edge of tarns (where there has been reindeer and bird manuring), and near pieces of old whalebone which are frequently found up to quite considerable heights.

Although the winter ice had for the most part disappeared from the bay by the second week of July, heavy pack had been driven in from Hinlopen, which made it difficult to use the small canvas canoe till towards the end of the month. On August 1 the motor boat arrived from the base, and ten days later Keith and Godfrey were back at the base.

## Conclusion and summary

By the middle of August 1936 the work of the expedition was over. Two weeks before Croft and Whatman had left on a climbing trip in Spitsbergen. Crossing Hinlopen Strait by open boat, they were landed at the northern extension of the Valhal Glacier, whence they made their way over the New Friesland ice sheet to the Lomme Bay Glacier. They succeeded in climbing several peaks in the Stubendorff Mountains as well as in the Chydenius Range and they sledged to the summit of Mount Newton. On August 21, despite a certain amount of trouble due to bad weather, they made their way down to the Ice Fjord, where they were picked up by the expedition ship, the m.s. *Heimland*.

Three days previously the *Heimland* had picked up the rest of the expedition in Brandy Bay. The base hut itself was bought by the Norwegian Government, who, during the voyage of the *Heimland*, have also had several huts built on the Seven Islands and King Karls Land. At the end of August the expedition reached Norway, where the equipment was changed over to the m.s. *Nord Kap*, which finally transported the expedition back to England.

The greater part of the plans had thus been successfully achieved, and the results obtained may be summarized as follows:

*Survey*

A plane-table map of the north coast and ice-free land has been made from Extreme Hoek to the east side of Dove Bay based on a theodolite triangulation. The latter was later carried on to the farthest East Land on the north coast, and Cape Leigh Smith Land has been fixed relative to the Base with an error of less than 30 metres. The coast and ice edge from Dove Bay eastwards were mapped by short base and photographic methods. An extension to the main triangulation was run southwards through Rijps Valley to Carfax Hill in Wahlenberg Bay. A somewhat rougher map was made of the Rijps Valley with the ice edge on each side.

A map was made of the area from south Lady Franklin Bay to Extreme Hoek on a scale of 1/100,000 by plane table alone. A less accurate map was made of the east coast fixed on to the Norwegian trig. point in Great Island, on Isis Point, and on Ice Point. This map differs considerably from the approximate sketch which showed all that was hitherto known of this coast. On the south coast a theodolite triangulation was carried from East Ulve Bay to Cape Torell, ice-free land being mapped by photogrammetric and compass methods. East Ulve Bay ought to be fixed relative to Cape Torell with an error of less than 100 metres. Practically the whole of the interior

of the West Ice was mapped in detail and in the five traverses made across the East Ice the greater part of this area also can now be mapped in some detail.

Thus North East Land has been almost completely mapped, the only gaps now remaining being between Ice Point and East Ulve Bay. Wahlenberg Bay still requires to be accurately plane tabled, although the north coast triangulation was extended through the Rijps Valley to the Oxford Peninsula.

*Winter work*

The latitude of the Base was fixed at 80° 23′ 06″ by ten stars—five north and five south—with a probable error of 1·½″ of arc, fixing by circum-meridian observations.

Local time for longitude was obtained by transits north and south and also by east and west altitudes. About forty stars were taken by each method. The results have not yet been fully worked out. The two methods, so far as has been computed, seem to give means with a probable error of less than $0^s.5$ of time each and differ by about a quarter. Extra time was spent on the longitudes because those of the Russo-Swedish Arc of Meridian points have not yet been satisfactorily fixed, and with that triangulation the new one is connected.

Observations of refraction were also carried out. Many low stars were observed during the longitude work, and the sun was observed at midday for several days during cold weather. These results indicate that the refraction differs very little from the computed figure. No observations on terrestrial refraction could be carried out, due partly to lack of time but mainly to the absence of calm periods.

Measurements of the horizontal deviation of the compass were made at the main trig. points, and on three days in the winter the variation was measured every hour during twenty-four. The mean deviation at the Base was about 2° east of north, and the daily variation about 1° with anomalies of over 5°. Deviation farther east has not yet been worked out.

*Geology*

The geological structure of the country was mapped in detail from Extreme Hoek to the head of Rijps Bay and from there across to the East Ice. Many sections were measured by different exposures, and it is believed that discoveries of fossil remains may lead to an accurate knowledge of the age of the Hekla Hoek formation. Observations were carried out on raised beaches and a collection of shells was also made on each of the four coasts of the country.

*Glaciology*

Two stations were maintained on the Inland Ice: a central station from September 1935 to mid-June 1936 and a northern station from November 1935 to March 1936. The balance of the West Ice during the period 1935–36 has been satisfactorily determined. The thermal conductivity of snow, firn, and ice has been estimated and the temperature gradient at 1·0, 1·5, 2·0, 2·5, 5·0, and 7·5 metres measured throughout the year. It was found that at a depth of 25 metres a temperature of 0·0° C. remained constant throughout the year. The rate of compression of the firn was measured and the length

of time for the change of snow to firn and from firn to ice was computed. The origin of blue bands was studied. The firn line was traced throughout the whole of North East Land, developing the observations of Professor Ahlmann. Considerable information as to the thickness of the ice covering has also been obtained. The change of frontal positions of two glaciers between 1924 and 1936 was measured. The general characters of the ice caps were studied, their dominant feature being their stagnancy.

*Meteorology*

Meteorological readings, dry and wet bulb thermometer, maximum and minimum thermometers, snowfall, hoar frost, wind force and direction, and ablation were made at 07.00, 12.00, and 17.00 G.M.T. daily at the Base between 15 August 1935 and 20 August 1936; at the central ice-cap station between September 1935 and mid-June 1936; at the northern station between 1 November 1935 and 1 March 1936, and at Murchison Bay between 25 April and 25 July 1936, as well as on all journeys. Full records of temperature, pressure, and humidity were taken by self-recording instruments at all three stations. Between September and May reports were wirelessed three times daily to the Norwegian Government Station at Bear Island. Measurements of radiation at low altitude were made at the central ice-cap station, but the prevailing cloud and bad weather handicapped this work. Preliminary discussions have been carried on in Oslo between the Norwegian Government authorities and the Chief Meteorologist, Mr. R. A. Hamilton, and early publication of results is expected.

*Ionosphere research*

Research on the ionosphere was carried on according to the programme made out by Professor Appleton of the Radio Research Station at Slough. This work has been successfully carried out between 1 September 1935 and 15 August 1936, and it is understood that particular importance attaches to the results in view of the unusual intensity of aurora display as observed in Tromsö early in 1936. It will be long before full results are available, but some notes have already appeared in *Nature* (vol. 139, p. 69, 1937).

*Aurora*

Photographs by the special "A" camera and full notes on auroral displays were made throughout the winter. Special runs were made in connection with the ionosphere research on every occasion when there was an aurora display overhead. Preliminary discussions as to the results obtained have been carried on in Tromsö between Dr. Harang, of the Tromsö Aurora Observatory, and Mr. R. A. Hamilton, and a summary of the results appeared in *Nature* (vol. 138, p. 1059, 1936).

*Measurement of atmospheric ozone*

The breakage of the day Spectrometer unfortunately much handicapped this work but photographs were taken of Polaris on every clear night throughout the winter. The negatives are now being developed, and results will shortly be available.

*Sea ice*

A complete record has been made of sea-ice conditions off the north coast and in North Hinlopen Strait from October 1935 to August 1936. Of interest in this connection is the surprising prevalence of open water up to 82° N. throughout the year.

Tidal observations were carried out by self-registering instruments during two lunar months.

*Biology*

Collections were made of plants and insects; the area most thoroughly worked being the north-west coast. Ornithologically the most important subjects studied were distribution and non-breeding. With regard to the latter, 1936 proved to be a non-breeding year, so that the expedition had an opportunity to study non-breeding in normal and abnormal years. The non-breeding was exceptionally high even in the former. Whenever possible observations were made on animal life during the winter, the populations at the leads of open water being especially interesting.

A detailed study was made of the sexual behaviour and breeding activities of several species. The most interesting of these was the purple sandpiper, and it was possible to compare the sexual behaviour of this species with that of the closely allied sanderling, and also the grey phalarope. The results of these observations should be most interesting.

For the success of the expedition great credit must go to the excellence of equipment. In the supply of this, the different firms who assisted the expedition deserve the utmost praise for the excellence of their products. In conclusion I should like to express my gratitude to the nine other members of the expedition who gave me never-ceasing support, and especially to the organizer, Dunlop Mackenzie, and to the second in command, Croft. To both the greatest credit is due for the part they played not only in the organization and throughout the expedition, but also in the very happy atmosphere characteristic of the whole expedition.

## APPENDIX II: SURVEY

It is hoped later to produce a detailed account of the survey, embodying descriptions of the methods employed, as well as the results, and at present it is unnecessary to give more than a brief outline. On the boat journey in 1935 and during the spring survey of the north coast, a plane table and theodolite were taken. Points were fixed with the latter, and where possible cairned; they were used as in ordinary topographical survey as control for the plane-tabling. On the summer journey made by Hamilton and Wright, a theodolite only was used, the triangulation was carried as far east as the ice cliffs, and the coast and ice edge put in by short base methods and rounds of photographs. By this means it is hoped that the whole coast will have been fixed with an accuracy of about 100 yards. The ice-free land has been contoured as far as and including the Rijps Peninsula. About thirty trig. points were fixed, and most of them marked by cairns at least 4 feet high.

During the spring journey as much time as possible was saved by only one man moving camp. While he did so the other was away, either plane-tabling

or occupying a trig. point, and they met at the end of the day at the prearranged site for the camp, generally 5 to 10 miles farther on. At each camp there was often two or three days' work, and so both men worked together, Mackenzie plane-tabling, and Wright either using the theodolite, hunting, or later relaying some of the stores on ahead. On the summer journey no plane table was taken and, as the bad conditions made it advisable to have two men with the sledge, they always worked together at the trig. points, Wright observing, while Hamilton booked and took rounds of photographs. Ordinarily a booker is unnecessary, though of course a comfort and an aid in carrying the theodolite. The dogs suffered from the heat, and were in any case unable to escape, so it was reasonably safe to leave them alone for sometimes over twelve hours. The advent of a bear at the camp would have complicated matters, but fortunately this never occurred.

The result of the boat journey in 1935 and the two sledge journeys in 1936 was to complete the survey of the north coast from Brandy Bay to the ice cliffs near Cape Leigh Smith. The country was contoured in 100-metre levels, as far east as Dove Bay, and it is anticipated that the eastern portion can also be completed. In the course of other journeys the greater part of the West Ice has been accurately contoured, and throughout the whole country extreme care was taken to survey accurately the ice edge. A reconnaissance survey was made of the east and south coasts, and the many traverses across and around the East Ice have given accurate knowledge of its interior. Finally, mapping was carried out on the west coast under the direction of A. S. T. Godfrey.

## DISCUSSION

Before the paper the PRESIDENT (Professor HENRY BALFOUR) said: We are to listen this evening to an account of the latest expedition undertaken under the auspices of the Oxford Exploration Club. In some ways one may describe this expedition as one of the most ambitious of the ventures of that Club and also as one of the most successful. The story, which I am not going to trespass upon, covers a period of rather more than a year during which the expedition lived in the northern part of Spitsbergen in an area which hitherto has been practically unknown geographically. It stands to the credit of the expedition to North East Land that it has come back practically intact. It suffered no major casualties at all. In fact, judging by the samples I have seen, I think I can describe its members as being all the better for their little outing.

The account is being given by the leader of the expedition, Mr. Glen, who is already well known in this Society, having lectured here before, and therefore I will not presume to introduce him to you. I will merely call upon him to give us his lecture.

*Mr. Glen then gave a summary of the paper printed above, and a discussion followed.*

The PRESIDENT: Mr. Glen has told us what a debt of gratitude the expedition owes to the Norwegian Government and to the Norwegians in general; also how very much it profited by their help. We are honoured to-night by the presence of His Excellency the Norwegian Minister. I ask him to come up on to the platform to address you.

H.E. The NORWEGIAN MINISTER: I did not think when I was invited to come here to-night that I should have the pleasure of listening to such an interesting lecture. I must say that I have saved time and money because I have been planning for some time past to try to use my first holiday to go to Spitsbergen

and see that wonderful country for myself; but I have been there to-night. I feel I know now much more about North East Land than through all the books I have read and the stories I have heard. I am extremely grateful to Mr. Glen for his lecture. It has shown that he has followed in the tradition of the explorers. They needed humour, perseverance, courage, and above all to work together as a team. Here in this country you go in for sport and you do it not in order to point to a man as being the best, but in order to get every man to understand that he can never be any good at all unless he can work with others. That is the backbone of the British race, and that is perhaps what has made your country the centre of the greatest Empire the history of the world has known. Mr. Glen has shown that up in the ice of North East Land he has been able, with his friends and collaborators, to work according to these same great principles and I, as a citizen of a smaller country, am proud to hear that he has found that we also have been able to work with him in the same spirit.

I have always found, when I have read the books of Nansen, Sverdrup, Amundsen, Scott, Shackleton, and other explorers of the Arctic and Antarctic, that they always kept in good spirits. The story we have heard to-night shows that the British Expedition of 1935–36 lived up to that principle, never giving up, but always trusting to pulling through; and when there was serious and difficult scientific work to be done, making it possible by looking also to the more human side of life, to the dogs and to the beauties of Nature—such Nature as we citizens of big cities dream of but very seldom have an opportunity of getting near to.

Once more I thank Mr. Glen for his lecture, and for everything you have done to help to explore a bit of a country for which my own fatherland is responsible. We hope that, with the help of such people as he, little by little this far-off part of the globe may become useful to humanity as a base for scientific work and perhaps also for other purposes.

The PRESIDENT: After those extremely kind remarks from the Minister I will ask if Mr. Binney will come and address us, as one of the pioneering explorers of former expeditions in Spitsbergen.

Mr. GEORGE BINNEY: There are four points in connection with Mr. Glen's expedition on which I should like to comment. The first point is the remarkable ingenuity with which he planned and carried out the art of living in the Arctic. He certainly made a virtue out of necessity in the way he and his companions lived in the ice cap. We have heard in the past less happy stories of living in the ice, but Mr. Glen profited by the experience of others in Greenland.

I think Mr. Glen tackled North East Land in the only way that it can really be tackled, that is to spend a year there and work late in the autumn and throughout the winter and in the spring; not during the summer. When the 1924 expedition was up there we had to sledge in August, and we had the great disadvantage of fog, which you get in the summer months, and also of very soft snow, with the result that on many occasions we could travel no more than 2 or 3 miles a day at the most: it was a case of tip-and-run. When we went out there we went out for three months. Mr. Glen did the job fully and thoroughly by staying for a year.

The Oxford expeditions, and the Cambridge expeditions for that matter, appear always to be assisted by the Services, and it is, I am sure, a matter of great gratification to the Oxford Exploration Club, of which I am a member, that we should have this assistance. In this case officers of the Royal Engineers and of the Royal Corps of Signals were lent to the expedition. Their services were invaluable. Finally, I would congratulate Mr. Glen on his leadership of

the expedition and on the fact that the members of the expedition worked in every way in harmony with one another.

Mr. ANDREW CROFT: I had hoped to be able to enjoy this evening in peace and it has come as rather a shock to be asked to say a few words. On behalf of the other members of the expedition I should like however to take this opportunity of thanking Mr. Glen for an absorbingly interesting year.

During the course of his lecture Mr. Glen suggested that I might say something with regard to dog driving and our dogs, but I fear I cannot attempt to do justice to such an involved subject now. The only point I can mention is that when we were sledging 12 tons of stores and equipment to the central and later to the northern ice-cap station we did *not* sit on the sledges as the picture showed.

One of the interesting points about the expedition is that although there were ten of us we were nearly always divided up into five or six different parties: and were never all reunited after the ship had landed us in North East Land. This of course had its elements of risk, but there is no doubt that it enabled us to do far more work than we should otherwise have done. And of course it had the enormous advantage that people had less opportunity of getting on each other's nerves.

An important factor, psychologically, was the dogs. They kept every one amused and helped to remind us, by their various eccentricities, of various friends and acquaintances we knew at home. Of course they were sometimes a mixed blessing, especially when "the blacks," who were a team of what I should term biters, used to have wholesale fights with all the remaining dogs, and get the better of them, unless one were constantly on the watch.

Only two of us knew anything about dog driving before the expedition started. Most of us learned the art by making countless mistakes, much to the delight of the dogs themselves. I think there can be no doubt that, pending the advent of really reliable mechanical power, dog traction is the most efficient method of transport in the Arctic. Sledges must however be improved, and possibly metal would be the best solution for combining lightness with strength. In any case, I think it is no longer necessary to infer that English people cannot drive dogs adequately without years of experience, for such a supposition is liable to handicap the future of Polar exploration.

The PRESIDENT: And now may we have a word or two from Mr. Godfrey, who was extremely helpful to the expedition.

Mr. A. S. T. GODFREY: You have heard a lot about the expedition and I would like therefore to say a word or two about something that is outside its province.

At the end of the expedition a Norwegian sealer steamed into the bay some five days before we were due back to civilization. I suddenly thought that I would like to go on a hunting trip to see the Norwegians shoot seals, bears, and walruses. Mostly owing to my good fortune in having as companions the members of our expedition, I was very far from being tired of the North. I had not had enough of it, so I went off for a month on a sealer. The crew could not talk English, and I had to learn Norwegian, and very charming they were to me.

These sealers go up through Tromsö and ports in the north of Norway to shoot the great bearded seal and also to shoot polar bears. That is the only unfortunate thing about these trips. We had seen plenty of bears on the expedition and we had to shoot them for dog food, but for the last four months Keith and myself were living alone and could rely on seal meat. So when we met a mother bear, which we christened Emma, and her two cubs Rupert and Olivia, we could leave them alone, and we spent many happy hours behind icebergs

watching the family play. The cubs' main amusement seemed to be clambering to the top of an iceberg and sliding down on their tummies, like small boys. Meanwhile the mother bear would be pouncing on lumps of ice and throwing them two or three feet over her head.

On the sealer it was different. We had to shoot the bears, and on this little vessel of 50 tons during the month we got 30 bears and 5 cubs alive. Mr. Glen has told you that a pair of trappers in the south of Spitsbergen got 120 bears in 1936. With all the other sealers up there something like 300 bears must have been shot last year. I feel this is a marvellous opportunity to suggest that some form of protection should be afforded to these beasts. You have all seen polar bears at the Zoo. I have had the privilege of seeing them alive and fighting against winter and rough weather, and I can assure you they are the most magnificent beasts in their native haunts. It would be a great pity if they were allowed to die out.

Mr. R. Moss: Up on the ice cap I had a very fascinating time. As you can well understand from the pictures, life there, at times at least, was very beautiful, but I must confess that I had done nothing to deserve that at all. What was done up on the ice cap was done almost entirely by the other members of the expedition. In its conception the idea was not mine; in fact it was all worked out long before I joined the expedition. All I had to do was to sit back there and enjoy life. The work of getting the stuff up there was not mine. I merely trotted along behind the sledge. The work was done by other people who looked after the dogs, as you have seen. In fact all I had to do was to meditate, and in that I was helped by my companions because, except for short week-end visits I only had one man at a time living with me, and I am sure that must have been a very grievous strain for all of them.

Mr. John Wright: I was more or less in charge of the survey, so that I think the best thing I can do is to give you, briefly, an idea of what our survey results were. After all, this is a geographical society!

Mr. Wright then gave a summary of the survey results. (See p. 309.) He concluded: It only remains for me to thank Mr. Glen for all he did in helping on the organization and carrying out the survey. He gave me a more or less free hand in England, not to buy instruments, because everybody was very generous in lending them, but to make special purchases and to do any adjustments which we could not get done otherwise, and he was extremely helpful, too, in the organization of the survey in North East Land. I should also like to thank him for the extremely clear and complimentary way in which he has described the activities of the expedition.

The President: Personally I have enjoyed this evening enormously. I gather from various expressions that you have done the same. The account to which we have listened was, in the main, of a narrative character, giving us an idea of the conditions under which the expedition was carried out, but at the back of it all, of course, there are the results which have been obtained and which will take some time to work out. I feel quite sure that when those results are available they will fully justify the expense and trouble.

It is quite clear that this expedition set out with definite objectives in view and that they were reached and fully carried out. It is very greatly to the credit of the organizer, the leader, and all those who took part that they brought this venture to such a successful issue. The organization seems to have been extraordinarily good. The leadership was most happy and, as you will have gathered from what you have heard and seen, there was a considerable amount of ingenuity available to meet special occasions. This ingenuity, which very often has to be improvised, as it were, is going to be of use to others who follow and find

themselves under similar conditions. Every expedition, if successful, becomes a stepping-stone to others which benefit from the ingenuity and resources of their predecessors.

The expedition to North East Land has shown very admirable qualities for the work which it had in hand. I cannot help thinking that one of its most valuable assets was a sense of humour, of which we have had samples this evening. Whether the expedition separates into small groups or whether it keeps together, a sense of humour saves situations better than anything else.

I am not going to keep you by talking myself, but I am quite sure you would like to thank Mr. Glen for his extremely interesting lecture, and I hope I may, in your name, congratulate the entire party on the success of their venture.

# THE OXFORD UNIVERSITY GREENLAND EXPEDITION, WEST GREENLAND, 1936

PETER MOTT

*Evening Meeting of the Society, 7 June 1937*

ON looking at a map of Greenland it is seen that the narrow strip of ice-free country, which runs up most of the west coast, is widest between latitudes 66° and 68°, where the ice has receded as much as 100 miles from the sea. Extending almost the entire width of this area is the Søndre Strømfjord, one of the longest and most beautiful of Greenland's innumerable fjords. The type of country in this district varies considerably, that near the coast being rugged and mountainous, while towards the inland ice the scenery grows milder, finally developing into an undulating steppe-land covered in low scrub and dotted with lakes of varying size. To the south, approaching the mouth of the fjord, is a large sheet of ice approximately 900 square miles in area, which rises to a height of 6000 feet at its centre, and is surrounded by high alpine mountains on all sides. In the past it has been referred to as the Sukkertoppen Ice Arm. The name implies that it is an extension of the main inland ice, and on most charts it is so depicted. This however was found to be erroneous, the ice there forming an individual cap of its own separated entirely from the inland ice by a valley 3 miles in width running north-east from the head of Evigheds Fjord.

North-east of the Sukkertoppen Ice Cap, a lake, Tasersiak, over 30 miles in length and up to 2 miles in width, follows along the edge of the inland ice. Although the lake has been known to exist for over half a century, it has, like the surrounding country, remained unmapped and unexplored until the last two years. The only people who ever go there are a few hunters from Sukkertoppen, who boat up the Strømfjord and then come down from the north on foot in search of caribou.

To reach Tasersiak, and to map the country in between it and the South Strømfjord, have been the main objects of the two expeditions sent out by the Oxford University Exploration Club during the summers 1935–36. A full account of the 1935 expedition, written by the leader, H. O'B. Hayward, was published in the *Journal* (August 1936).

For a variety of reasons, the chief of which was lack of time, the first expedition failed to reach the lake or to penetrate very far inland. In the spring of 1936 a second expedition was therefore organized, under the leadership of the author, which planned to make a fresh attempt on Tasersiak, and to further the survey work carried out by Hayward in the previous year. Amongst those anxious to join were two biologists, so that it was decided to increase the scope of the work by the addition of a biological party, which would however be quite independent of the survey party while on the ground. The following composed the personnel: W. R. Plunkett, J. C. G. Sugden, T. H. Kershaw, E. W. Etienne, J. C. S. Beard, and myself (surveyors); J. S. T. Gibson, H. G. Vevers, D. M. Steven (biologists). Mr. H. O'B. Hayward acted as Home Agent.

On June 4 the expedition sailed from Copenhagen on board the Danish Government boat *Disko*. Cape Farewell, the southernmost point of Greenland, was sighted on the tenth day out. Soon we were skimming along the edge of the brash ice with numbers of fantastic-shaped bergs round the ship, and the ever-present outline of the mountains beyond. After calling at various settlements on the way up the coast, the *Disko* arrived at Holstensborg on June 20. On going ashore we were received by the local governor, Herr Rasmussen, who had kindly arranged quarters for us over the store room. The following morning the six of us comprising the survey party transferred our food and equipment to the *Nakuak*, a small Eskimo motor fishing boat, which was to take us the rest of the way. We sailed in the afternoon, having parted from the three biologists, whom we were not to see again for eleven weeks. They had arranged to spend half their time in the Amerdlok Fjord, just south of Holstensborg, and then proceed to the head of the Strømfjord, where they would be able to make use of the huts belonging to Professor Hobbs of Michigan University, who had been generous enough to put them at the disposal of the expedition. A preliminary account of their work appears in Appendices III and IV.

The scenery south of Holstenborg is superb, and as the *Nakuak* threaded her way through the maze of coastal skerries, some magnificent views were obtained. At the entrance to the Strømfjord the mountains, which rise to over 3000 feet, were covered with patches of snow down to the water's edge. The sea was so calm that the perfect colourings of the sky and scenery were reflected in its mirrored surface. In the morning however it clouded over and some snow fell.

It was midday when the *Nakuak* anchored off the Sarfartok Estuary, a wide expanse of mud-silt flats, which provide a delta mouth for a large glacial river of the same name. Although the estuary is as much as 60 miles from the coast the tidal flow there is considerable, and at high water the tide advances over 2 miles inland. In order to avoid last year's difficulties it was decided to attempt a landing on the north shore of the estuary against the current of the river that flows out into the fjord on that side. This proved no light task. To begin with the distance from the ship to the nearest land could not have been less than half a mile. The *Nakuak's* dinghy, like most Greenland rowing boats, required the maximum amount of labour to propel it. However with the help of our crew of three Eskimos we managed to get two boat loads a considerable way up the estuary. In the middle of operations the tide receded, making it necessary to land the remainder of the stores in a most awkward little cove with no beach at high tide, and 2 miles from the only possible site for a base camp. Altogether it took ten hours to get everything on shore. As the little motor boat disappeared down the fjord with the three Greenlanders on board we realized that preliminaries were at last over, and the real work about to begin.

No better site for a base camp presented itself than that used the year before, which proved to be the only place on that side of the estuary with a water supply. It was an impressive spot, situated at the foot of a huge cliff, 3000 feet high, which towered almost vertically above the camp, while 30 feet below the Sarfartok River swirled past at a great rate. The next two days

were spent in fetching up the food and gear dumped along the shore, most of which was carried out in the two collapsible canvas boats (*folbots*) which had been brought for the purpose.

In the latter part of its course the Sarfartok River flows down to the fjord in a wide glacial valley enclosed by high cliffs of greyish-brown gneiss, banded with dark veins of dolerite. Isolated in the centre of the valley, 3 miles up from the estuary, is a hill 600 feet high, covered in a mass of loose stones and boulders on the top, and having a thick growth of low birch and heath on its east and west faces. Originally the glacier, which filled the valley, must have flowed round, and probably over, this hill. Being of harder rock than its surroundings, Curtain Hill appears to have withstood the pressure of the ice, and now remains an effective screen, cutting off all view of the valley from the fjord. The river makes its own way round the south side of the hill, and in doing so descends 50 feet in a series of rapids, which are quite impassable for a boat. A curious feature of the west side of the hill is a number of glacial silt mounds, in shape resembling small icebergs: the mounds are formed of hardened laminated silt, and appear to be the remnants of a lake terrace. (See Appendix II.)

Thirteen miles farther east the Sarfartok Valley is again blocked, this time by the sheer face of a mountain, The Island, which reaches a height of 3000 feet, and stands majestically apart from the surrounding ranges. Just below The Island the Sarfartok is joined by a smaller stream of clear transparent water, there being a strange contrast at the junction of the two rivers where the clear stream meets, and is swallowed up by, the cement-coloured silt, which renders the Sarfartok opaque. A similar join occurs at the mouth of the estuary where the silt of the Sarfartok meets the clear fjord water. On the north side of The Island, the Clearwater flows down a continuation of the main valley, while the Sarfartok emerges from the mountains to the south.

We decided as far as possible to keep to the north bank of the river, which was the more direct route, though in some ways the most difficult. Two miles up from the base camp the river made a right-angle bend after circumventing Curtain Hill. Above the bend were the rapids, while, just below, the north bank developed into a very steep scree slope extending for half a mile, across which it would have involved a considerable risk to try and pack heavy loads. There were thirty-one cases of food as well as survey and camping gear to be taken inland, weighing in all over half a ton. Two alternative courses were possible: either to carry everything round the south bank of the river, or to effect a crossing just above the bend in question. Since time was the main consideration, we decided on the latter course.

On the north bank were Plunkett and I, who had come over the scree, while on the south side were the remaining four with all the provisions they had towed up from the base camp. After trying several unsuccessful methods of getting a line across, Etienne managed to paddle over with a ball of light string attached to the bows of the folbot. In this way a ferry system was eventually formed across the river (180 feet wide at this point) using the climbing rope and cable, each being attached to the bows of the second boat, and the free ends anchored on either shore. The banks, a mass of loose stones and boulders, made it very difficult to get a foothold. The first load however

reached the north shore intact, and the boat was returned for a second journey. Altogether six trips of this nature were made, and there were then three "passengers" still to come. For all three to have been in the boat at the same time would have been very risky in so fast a stream; a final ferry-crossing was therefore made with Beard as passenger. Last of all the boat was returned to Sugden and Kershaw, who had to make the crossing unaided. They began some way upstream, just below the rapids, but this proved rather too high and at one moment they were carried rapidly backwards downstream. Fortunately they were able to regain control, and after a strenuous paddle arrived safely. The whole incident took seven hours, and it was midnight before we reached our camp on Curtain Hill. There being perpetual daylight at this season one lost all idea of time. In many ways it was preferable to work at night, when it was cooler and the mosquitoes less active. Several times we contemplated reversing our time-table, but the heat of the day proved too severe for sleeping.

On the last day of June Sugden, Etienne, Kershaw, and Beard started up the river with the two folbots, which had been rebuilt on the far side of Curtain Hill, just above the rapids. It took the boat party twelve hours of towing to reach the mouth of the Clearwater, a distance of only 10 miles by land, due almost entirely to the nature of the banks, which were mostly over 30 feet in height, and composed of loose glacial silt on which it was impossible to get a firm foothold. There was also the constant danger that such high terraces of dry sand might collapse without warning. Two months later, on our return, we found that this had in fact happened and in many places our former towing-path no longer existed. The next morning the distance downstream was covered in a mere two hours.

Two days later Sugden, Plunkett, Etienne, and I began a second journey up the river with the rest of the provisions. By using a double tow-line 100 feet in length it was found possible to manœuvre the boats from the top of the banks, which greatly facilitated progress. There were however frequent bends where the stream formed backwaters, and at these places the boats had to be held off the banks with a paddle. When emerging from such a backwater the full force of the current would catch the boat with a tremendous jerk, and even when fully prepared the tug on the tow-rope was strong enough to pull any one of us off his feet. At a bend of this nature, not far from the place where Atter lost his life the year before, one of the folbots came to grief. Sugden and I had already rounded the corner with considerable difficulty. Plunkett and Etienne were following, when their boat was caught suddenly in the current and the pull was so strong that the two of them together were unable to hold on to the rope. The boat overturned, but fortunately became stranded on a sandbank 300 yards farther down, and was rescued almost intact. Miraculously also, a number of things still remained in the upturned boat, and these were retrieved. We lost our only two pairs of binoculars, two clinometers, and a great deal of photographic apparatus, but were lucky not to have come off worse. As a result of the accident only a single day was lost, while a party was sent back to bring up further provisions. After the rescue both boats were dismantled, and the rest of the journey to the Clearwater made overland.

The temperature during these days was extraordinarily high, a maximum of 90° in the shade being recorded at 6 a.m. on the morning after the accident: almost a record for the arctic. Packing heavy loads in this heat would have been unpleasant enough, but it was made doubly so by the mosquitoes, which came in vast swarms, and never ceased their activity for one moment during day or night. We found it necessary to wear a veil at all times as well as considerable protection to arms and legs.

The boats were rebuilt on the Clearwater, and towing began again to a new camp situated 6 miles up the Clearwater Valley at the foot of a range of hills beyond The Island, which were our next objective. It had been thought that towing up the Clearwater would be easy compared with the difficulties of the Sarfartok. Such hopes were unfortunately not realized, the banks being covered in thick willow growth up to 5 feet in height in which the tow-rope continually became entangled. In many places the ground was boggy, and the discomfort of the mosquitoes, which emerged in clouds from the undergrowth, was intense.

By July 10, twenty-four cases of provisions as well as camping and survey equipment had reached the next camp at the foot of Barrier Heights. Here the Clearwater Valley took a turn to the north-east, while our route lay almost due south, so we parted company with the river, not without some feelings of relief. There were several interesting features near the new camp site. The colour of the cliffs bounding the north side of the valley suddenly changed from the usual greyish-brown to a deep terracotta shade, and the range ended in a bluff, the lower part of which was composed of an exceedingly steep scree slope of the red gneiss, extending for 1000 feet. We named the place Devon Scree, the colour of the rock resembling that of the soil in parts of Devonshire.

Emerging from the hills to the south of the camp a rapid mountain stream, Boulder Torrent, spread out into a delta bed before joining the Clearwater. The delta extended for about a mile, and was covered in a dense wood of willow scrub, nearly all of which reached a height of 12 feet, a rarity so far north in Greenland. Once in this wood progress became almost impossible, because of the boggy nature of the ground and the densely packed branches. In one instance we took a full hour to find a way out.

Behind the camp were a group of Eskimo houses, built with a low stone wall and an ingenious roof of dried willow branches to serve as a support for a waterproof decking. Near the encampment lay a burial ground full of the skulls and bones of past hunters. The huts are still used by the two Sukkertoppen families who visit the district, and on their return journey Kershaw and Beard found them occupied.

The country ahead was now completely unknown, since the farthest camp inland of the 1935 expedition had been passed. On July 10 a reconnaissance was made up the ridge of hills already referred to, and which we had named Barrier Heights since they cut directly across our route. From the summit of these (2700 feet) we obtained a magnificent view of the surrounding country. From what I had seen the previous summer I had expected to find a series of ridges running parallel with the fjord, separated from one another by deep valleys. Instead, we found ourselves on top of a high barren plateau extend-

ing southwards to the ice cap, which appeared as patches of dazzling white on the horizon. Only 2 miles away lay a clear blue lake of considerable size, which it seemed might prove a possible route for further boat work. After planning a base line for the survey we returned via a precipitous gully to the camp at Devon Scree.

The next three days were spent in getting everything up to the top of Barrier Heights, involving a climb of over 2000 feet, which had to be repeated four times. Every journey each man carried a load of 40 lb. or more on his back. The heat was still intense, and the mosquitoes as bad as ever. The second day, when we made two such climbs, proved to be one of the hardest on the whole expedition.

We pitched the next camp at a height of 2050 feet on the banks of Boulder Torrent, which was found to flow from the new lake which we named Hopeful. Never again had we to descend below the level of this camp, and to reach the highest points of the surrounding country it was only necessary to climb another 2000 feet. Although the temperature was considerably lower than in the valley, the mosquitoes were as active as ever. These persistent tormentors followed us even to the tops of the mountains. On one occasion, 3500 feet up with a stiff wind blowing, the insects were so thick that on picking the alidade off the plane-table a wide black line of dead bodies remained. They made the survey at times impossible, and did much to impair our work, our sleep, and our tempers.

During the initial triangulation and survey, which was carried out from Boulder Torrent Camp, it became evident that Lake Hopeful would not after all live up to its name, and that the shortest route to Tasersiak lay overland to the south. The data on the chart however could not be relied upon, and in order to prevent an abortive trek in the wrong direction it was decided to make a rapid reconnaissance journey to find out the exact position of Tasersiak. On July 17, Sugden, Kershaw, and I set off with provisions for three days, one small tent, and the lightest of equipment. We set a course due south from the camp, which would bring us to the western end of the lake, if the map was correct.

The first five hours consisted of a steady ascent over a dreary tract of country, strewn with rocks, and scant of vegetation. This came to a sudden end in an abrupt descent to a deep valley where the Sarfartok had cut out for itself a canyon of spectacular proportions. The total length of the gorge was about 10 miles, divided up into two stretches at right angles to one another. The cliffs hemming in the river were vertical rock walls 800 feet high, at the bottom of which the water rushed in a wild boiling fury, filling the air for miles with its roar.

In the direction of the lake lay first a high ridge running due west, then a further valley at right angles to the canyon, and beyond a second ridge, higher and more formidable than the first, appeared to be the final obstacle barring approach to the lake. Progress now became more difficult, but after two hours of hard scrambling we reached the bottom of the valley, and crossed a clear stream at its foot, which bubbled happily over a chaos of boulders, until it finally disappeared in a last plunge to the canyon below: we called it rather prematurely, but justifiably, Last River.

*Tasersiak and the Sarfartok River*

*Evigheds Fjord*

*Moraines north of Sukkertoppen Ice Cap*

*Mountains of Evigheds Fjord*

*Mount Taterat and Evigheds Fjord*

It seemed to be but a question of an hour to reach the summit of the final ridge. The lake however was better guarded than we had bargained for, and after struggling for three hours over an endless series of escarpments we finally pitched camp for the night at a height of 3800 feet by the edge of a small tarn in the middle of a sea of boulders.

In the morning, only 100 yards farther on, this rocky wilderness finally came to an end: 2000 feet below was the Sarfartok again, but in a considerably milder form than when last seen. Beyond, the valley sloped up steeply to the edge of the ice cap, while south-east a glacier stretched in two arms down to the river, ending in a huge cliff of ice. It took an hour to reach the valley. Here the Sarfartok was found to emerge from a large glacial lake, which could be none other than Tasersiak. We had at last achieved our goal. The water of the lake was a dull grey colour, like that of the Sarfartok. The shore also was composed of high silt banks similar to those encountered in the lower reaches of the Sarfartok. We pitched camp 6 miles up the shore, where the lake took a sudden turn in a north-easterly direction.

Opposite the camp, on the far side of the lake, a valley 3 miles in width extended southwards to the high snow mountains, assumed to be part of the coastal ranges at the head of Evigheds Fjord. The valley was of peculiar interest since it separated the inland ice completely from the so-called Sukkertoppen Ice Arm. On either side a series of magnificent glaciers flowed down between high nunataks, but nowhere had the ice formed across the valley.

Early the next morning we began the return journey. After a gradual ascent lasting about an hour, we found ourselves once more on the top of the barren ridge that had caused so much trouble on the outward route. We took six hours to get diagonally across this extraordinary mountain, and it was necessary to keep a continual check on the compass because of the total lack of any definite object, despite the fact that visibility was perfect. For the rest of the way we followed on our old tracks, and after thirteen hours' travelling reached Boulder Torrent, the distance covered being 17 miles, and the journey involving two climbs of 2000 feet.

As a result of the reconnaissance the route to the lake was now in no doubt, and it was only a matter of time and labour to get there. During the next ten days we split into two parties for the greater part of the time. Plunkett and I worked at the survey, while the others had the unpleasant task of packing heavy loads over the worst bit of country in the district. The weather, which had so far remained unbroken, suddenly changed. It rained, and there was constant mist driving up from the Sarfartok canyon. On several days surveying was impossible, and on others visibility poor, with intense cold on the tops. We found the back-packers gaining on us, and had to push the survey forward at an unsatisfactory rate, so that much of the work was necessarily sketchy.

In spite of the inclemency of the weather, and the difficult nature of the ground, by July 31 provisions for two weeks together with one boat, three tents, survey and personal kit, had reached the lake, the credit for which lay with the back-packers who, with loads weighing anything up to 60 lb., made journeys to and fro, sometimes covering 15 miles in a day. The most useful discovery was a route along the banks of the Sarfartok, making it possible to

circumvent the ridge. If it had not been for this I very much doubt if we could have made more than a series of excursions to the lake, since the difficulties of transporting heavy loads over the mountain would have proved too great in so limited a time.

On August 1 the arrival at the lake was celebrated by the distribution of an extra day's ration. We had now been on a 28-oz. ration for five weeks, and the strain of the past fortnight was beginning to tell. No one complained but an unusual lack of cheerfulness and vigour told its own story. The effect of doubling the ration for a single day was instantaneous. Spirits rose and every one became again his normal cheerful self.

We spent altogether a week on the lake during which time much was achieved. On August 3, Sugden, Kershaw, and Etienne, set off to examine the possibility of making a return to the base camp via the edge of the ice. While we others were spending the hours in a dripping tent lamenting the impossibility of doing anything, since it was thick mist outside, Sugden and his party crossed the glacier, examined a camp site on the far side, and returned to the lake in a matter of four hours. This was far beyond our most optimistic hopes, and it was thereupon decided that four of us should go back by the ice, while it was necessary for two to take the old route in order to clear the dumps of food and gear left behind.

Before our departure one final trip of an interesting nature was made by Kershaw, Etienne, and Beard. After crossing the lake opposite the camp, they set off down the valley towards the head of Evigheds Fjord. They found that 6 miles from the lake the valley dropped suddenly into a gorge of striking proportions, even more impressive than the Sarfartok canyon. Beyond the gorge there was a further drop of 1000 feet down to sea-level. Glaciers from both sides of the valley poured down to the fjord forming there a glacial basin frozen all the year round. The mountains hemming in the ice cap were similar to those near the entrance of the Strømfjord, though considerably higher, and with more snow on their tops.

On the morning of August 7 we had to part from Kershaw, and Beard, who were to return to the base camp by the outward route. The remaining four of us with provisions for six days, two tents, the boat, and all the survey gear, would go back by the ice, thereby making a complete circuit of the ground being surveyed.

It required two journeys to get everything across the lake, after which the boat was dismantled and, heavily loaded, we started for the edge of the glacier. At close range the walls of the Sarfartok Glacier were a remarkable sight. Due to the steepness of the slope, the ice had formed fan-shaped seracs, grouped in a series of tiers, below which the glacier dropped to the river in vertical ice cliff 150 feet high. Every few minutes a section of the cliff face calved off, filling the river with fragments of ice, and causing a report like the firing of a battery of guns. On its eastern limit the glacier had formed the half of a bowl, and proved a suitable place to begin the ascent, since the surface of the ice there was firm and uncrevassed. After reaching the top we struck straight across between the two uncrevassed regions. Compared to what we had been used to, progress was easy, the only obstacles being small rapid streams that rushed helter-skelter down channels in the ice. On the far side

*An Eskimo shelter of willow branches*

*High willow scrub, Clearwater Valley*

*Towing from silt banks*

*Sarfartok canyon*

*Southern limit of canyon*

we found a delightful little lake situated on the edge of the glacier, where small icebergs glistened and sparkled in the sun. Here we decided to camp beneath a large boulder, providing shelter from the wind. The ground was a mass of rocks, and it took over an hour to clear a space big enough to pitch the two tents, in the course of which we had to hack out with an ice-axe a pair of boulders requiring three people to handle them. As a result of the height of the camp (3500 feet) and its close proximity to the ice, the temperature was low—usually a degree or so below freezing. The next two days Plunkett and I spent on the summit of a jagged mountain behind the camp, while Sugden and Etienne packed loads. The second day we were caught by a snowstorm on the tops, and forced to make a hurried descent to the camp, thereby spoiling our chance of completing the work.

It was decided to make the next, and possibly the last, camp near the summit of a high mountain emerging from the edge of the ice at a distance 5 miles farther east. On the second day Sugden and Etienne packed a load there and the following morning we moved camp. It was an easy journey involving a gradual climb of 1000 feet over the ice. On the way we encountered some wide and extraordinarily beautiful crevasses, hung with stalactites of unusual forms. We pitched the tents within shouting distance of the summit of the mountain (4700 feet), the highest point yet reached. For the survey it proved a most valuable station since practically the whole of the country mapped was visible from the top of the mountain. Night temperatures were now well below freezing-point, and never rose above it during the day, so that all water had to be thawed from blocks of ice. Owing to lack of provisions only one day was spent at this camp.

The last stage of the journey lay across an ice tongue which extended for 6 miles inland and was 3 miles in width. So far it had been a gradual climb all the way; now a constant drop back to the base camp lay ahead of us. In spite of the fact that we had only one day's provisions left, the loads were some of the heaviest yet carried owing to the fact that two journeys had been made previously over each part of the route, and we were now carrying a double pack. After a hard scramble of a mile over loose rocks and up the side of a steep moraine, we found ourselves once again on the ice. The glacier had the appearance of a choppy sea frozen suddenly solid; on the western limit, and again two-thirds of the way across, the ice had formed into a mass of small hummocks up to 10 feet in height. They were not pressure ridges, and did not appear to conform to any specific alignment or configuration, except in one isolated case where a straight ridge stretched diagonally across the glacier.

On reaching the far side, Sugden and Etienne continued on down to the base camp, which they reached the same evening, while Plunkett and I, with the remaining food, spend a further two nights on the tops for the completion of the survey. The weather was ideal, and we managed to finish off the map in a most satisfactory manner. By August 13 all six members were back at the base camp.

There still remained three weeks before our return to Holstensborg. We therefore planned to utilize part of this time in making two excursions onto the Sukkertoppen Ice Cap. The first, of a reconnaissance nature to find out what conditions were like on the ice, and to get as much incidental informa-

tion as was possible, was made by Sugden, Etienne, and Beard, and proved highly successful. They camped two nights on the ice, and made some interesting studies of the eyebrow moraines near the Cusp Mountain, where we had our last camp on the return journey from the lake.

During the latter part of the survey theodolite rays had been taken onto a distant nunatak, just visible above the horizon of the ice. It appeared to be situated at the head of the western arm of Evigheds Fjord, and there was such a mountain marked "Taterat" on the Admiralty Chart, but no height was given to the peak nor to any point in the surrounding ranges. The object of the second journey was to make a crossing of the Sukkertoppen Ice Cap in the hope of reaching this mountain, and to investigate what happened on the far side of the ice. The distance across the ice cap, as calculated from our theodolite readings, was 30 miles.

On August 19 Plunkett, Kershaw, and I set out with five days' food and the minimum of equipment. The first day we climbed 3500 feet up Snowy River Valley to the tent, which the first party had left pitched a mile from the edge of the ice. By the middle of the second day we had gained a further 1000 feet, and left the land far behind. Progress underfoot was wretched. Everywhere were slush pools covered by a thin layer of ice, which gave way under the pressure of our feet, precipitating us up to the knees in ice-water.

That evening we pitched camp just above the snow-line. The weather, which had remained unbroken all day, clouded over, and a low mist descended, blotting out every landmark. The temperature dropped to 22° before we shut down for the night. In spite of having no winter equipment we kept perfectly warm, as the secret had been discovered of concentrating spare clothes underneath our sleeping bags. When pitching the tent we laid first a thin groundsheet on the snow, on top of this a light rug, then the tent with groundsheet attached, and lastly a thick rug to insulate us from the floor of the tent. In the morning moisture was found to have condensed on the bottom of the thick rug, but the top side remained dry, and we were never cold, in spite of the fact that our sleeping bags weighed only 2 lb. We owed the method of arranging the tent to the reconnaissance party, who had experimented with different ways on the worst form of wet ice. Pitching the tent gave no difficulty as the pegs froze in firmly as soon as they were driven into the snow.

On the third morning a thick mist surrounded us on all sides which reduced visibility to half a mile. There was no time to wait for the fog to rise, so we relied entirely on the compass, continually looking back to keep a check on our tracks in the snow. By midday we had climbed to a height of nearly 6000 feet, and were now on the summit of the ice cap. The condition of the snow was average; with skis or snowshoes it would have been easy going, but we had not come equipped for this type of work. By timing our paces we calculated our average speed to be $2\frac{1}{2}$ m.p.h. According to reckonings we had another 16 miles to go. Before lunch the weather showed signs of clearing, and about 1 o'clock the cloud obscuring the horizon lifted for a minute. Dead on our course there loomed up out of the mist a mountain, higher than any we had yet seen. Our tracks alone were sufficient to tell the story, for they suddenly converged from a single straight line to a chaotic circle of footprints !

After making certain of our bearings, we set off again full of confidence, and with a quickened pace, aided later by the wind, which rose to gale force driving everything before it in a hail of minute snow particles. Later the clouds again lifted revealing a magnificent range of snow mountains, which gained in grandeur as we approached. It took a full two hours to reach the nearest of a series of snow mounds, dividing us from the mountains. Since it was growing late, and the wind gaining in force, we pitched camp on the far side of one of the mounds in full view of the mountains, only a mile or two away. Some of the peaks looked as if they had been cut out of white cardboard to decorate the backcloth of a stage. Below the camp a number of glaciers flowed down into a great bowl from which there was no visible outlet. South-east an ice dome towered above everything without a vestige of rock showing for 2000 feet below its summit. In the evening, when it grew dusk, the tops of the mountains turned pink, and the Northern Lights flickered green above them. It was cold that night and the wind bitter; the thermometer registered 20° of frost. In the morning the inside of the tent was covered in hoar frost.

There remained enough food for three days. Since we calculated that it would take us less than this to do the return journey, we decided to push on in the morning for a further mile or so in the hope of getting a glimpse of Evigheds Fjord. Leaving the tent pitched, we started up the next rise. The day was perfect with little wind, clear skies, and a dazzling sun. As we topped the rise further ranges came into view, and finally we found what we had hoped to see—6000 feet below lay the main arm of Evigheds Fjord stretching in a brilliant blue ribbon to the sea. The cliff sides of the fjord rose to thousands of feet, and ended in ragged pinnacles of rock. From where we stood a glacier drained down to the fjord ending in a delta a mile in width. In the centre of all domineered the magnificent bulk of Mt. Taterat, situated between the two arms of the fjord. At a conservative estimate the height of this mountain is not less than 7500 feet, making it possibly the highest peak in West Greenland. Unfortunately we had been unable to bring instruments with us because of the necessity of dispensing with everything but the absolute essentials. It was therefore impossible to obtain any verification of the height, but it is sufficient evidence of its size that Taterat shows well above the sky-line at a distance of 30 miles away with the ice cap in between rising 1000 feet.

The sun was at its zenith when we tore ourselves away from an unforgettable scene, and turned homeward. On the return journey we were able to follow our old tracks, which had become streamlined as a result of the wind during the night. Proof of the strength of the wind, and incidentally of the toughness of insects, was the finding of a considerable number of mosquitoes still alive and crawling on the snow in spite of the fact that they had been blown for 20 miles across the ice on the coldest night we had yet experienced. The surface of the ice was good, so that we were able to camp that evening on the highest point of the cap. The next day it was downhill most of the way, and conditions were so excellent that we covered a distance of 20 miles, which enabled us to get off the ice and to pitch camp at the head of Snowy River Valley. It was fortunate that we did so, for in the morning Plunkett developed an acute attack of snow-blindness. A descent of 3000 feet lay in

front over loose stones and boulders, where it was impossible to give assistance. Ordinarily the journey down took three hours, but with a "blind" man we were lucky to do it in double that time.

The remaining week was taken up with a detailed survey of the estuary, and with astronomical observations for latitude and azimuth. On November 3 the *Nakuak* arrived, and after picking up the biologists at Hobbs' camp, the whole party returned to Holstensborg, and three days later sailed in the *Disko* for Copenhagen.

Our gratitude is due to all those by whose assistance the expedition was made possible. Especially we would like to thank Mr. Daugaard-Jensen and the staff of the Grønlands Styrelse, the Expedition Council of the Oxford University Exploration Club, The Oxford University Hebdomadal Council, The Council and staff of the Royal Geographical Society, Professor Nørlund and the officers of the Danish Geodetic Survey, Col. M. O'C. Tandy of the Oxford University Survey School who lent instruments and gave special instruction to members, Professor W. H. Hobbs of Michigan University for the loan of his huts and gear at Camp Lloyd, Dr. S. Zilva for his valuable advice with regard to our diet, all those who helped us financially, and those firms from whom we obtained goods free or at reduced prices.

## APPENDIX I: SURVEY

P. G. Mott

The main triangulation was carried out with a 3-inch Carey vernier theodolite, which weighed with stand approximately 15 lb. With careful handling the instrument read to 1 minute. For detailing, light army-pattern plane-tables, 18 inches square, were used. Contours were drawn by taking spot levels and sketching in the form lines at intervals of 500 feet. Owing to the loss of both clinometers (which were of Indian pattern) before the survey had begun, all heights had to be taken with the theodolite—a laborious process, the additional accuracy of which did not compensate for the loss in time. A scale of 1 inch to the mile was used in the field, but later reduced by half.

In the limited time at the disposal of an expedition of this nature, it would have been quite impossible to cairn every triangulation station. Very few mountains have a peaked summit, and viewed from different angles may present entirely different aspects. From any one particular direction the real summit of a mountain may be invisible, and a ray is easily taken on to a false point. This difficulty was the cause of a great deal of confusion and delay, which was further increased by the loss of both pairs of binoculars in the boat accident.

When surveying from two or more route stations, "A," "B," "C," etc., if, while plane-tabling from "A," the ground ahead was such that a forward station "B" was readily identifiable, the following method was found useful. A forward ray was taken to "B"; on arrival at "B" the plane-table could be rapidly orientated by aligning back on "A": "B" could then be resected by making use of only one main triangulation point, although it was obviously advisable to check on a second point if possible. This method was found to be of particular value in rough country, where more than two triangulation stations were seldom simultaneously visible.

In all, three separate base-lines were used. The initial, and main base, was measured by a subtense method between two small hills, on the top of Barrier

Heights, situated half a mile apart. A second base was taken along the north shore of the Tasersiak, from which the lake and the surrounding country were mapped. The third base-line was used in the detailed survey of the estuary, which was made to a scale of 2 inches to the mile, from Curtain Hill to the west shore of the Stromfjord. Finally all three maps were tied together on the $\frac{1}{2}$-inch scale.

Latitude and azimuth were fixed on arrival by observations to the sun, and checked again before departure by various stars, including Polaris. The instrument used was a 5-inch vernier Carey theodolite of an old pattern, the accuracy of which was low. It may however be safely assumed that the latitude reading of 66° 29′ 50″ for the summit of Curtain Hill is within half a mile. Due to the failure of the wireless receiving set, and the low accuracy of the theodolites, readings for longitude were out of the question.

## APPENDIX II: GEOLOGY

J. C. G. SUGDEN

The area as a whole may be described as plateau country with an average height of 4000 feet, and deeply bisected by glacial valleys. The direction and shape of these, and especially the continuation of some of them in valleys on the other side of the fjord, seem to indicate the widespread influence of faulting. The line of the lower Sarfartok Valley, for example, is continued on the north-west side of the fjord by a depression leading to Itivdlek Fjord, while the course of the Sarfartok (in the canyon) seems undoubtedly to have been dictated by structural weaknesses.

Except on the bottom and lower slopes of the valleys there is little or no soil covering. Most interesting is the lower Sarfartok Valley, which is covered with a thick layer of glacial silt that appears to have been deposited while lake conditions were prevailing. In fact the valley has every appearance of having formerly been occupied by a lake, and the river now meanders across its bed from one side of the valley to the other, having cut for itself a channel varying from 30 feet deep at The Island to 80 feet near the fjord. The terrace thus formed is continued below Curtain Hill, which cannot therefore have caused the lake. The occurrence of raised beaches of similar height at the head of the fjord (30 miles north-west) points to a change in the relative level of the water throughout the whole fjord. Unfortunately nothing is known of the depth of the fjord.

Beyond Curtain Hill, and somewhat removed from the modifying influence of the fjord, the dry summer conditions and the intense sunshine have had a marked effect on the vegetation. Very high temperatures were recorded (90° F.) especially on the north bank of the river, which faces the sun during the period of its highest ascension, and which receives added heat by reflection from the exposed cliff faces above. Consequently desert-like conditions prevail on this side of the river, and there are large expanses of sand and gravel with no vegetation. Miniature sandstorms were also a feature, while, on the south side, which is sheltered from the most vertical rays, vegetation covers the terrace throughout the whole length of the valley.

Beyond The Island (15 miles from the fjord), the main glacial valley is drained, not by the Sarfartok, but by Clearwater River. Not being under the direct influence of glaciers, this river has a much more consistent flow, with the result that a thick, and comparatively high, growth of willow can flourish on both banks for the greater part of its course.

Meanwhile the Sarfartok, from the Tasersiak to The Island, is confined

within a deep canyon—another evidence of dry summer conditions. The east-to-west reach of the canyon is continued by Last River Valley. This was very likely occupied by a glacier of a less powerful type, which joined the main valley just below The Island. It would not have cut so deep an incision, and the bottom of the original glacial valley was probably at the same level as Last River before it falls into the Sarfartok Canyon. Furthermore, this part of the Sarfartok Valley has the appearance of a shallow glacial valley with a canyon cut in the bottom.

The Tasersiak Valley itself also has typically glacial features. Former levels of the lake are indicated by raised beaches and promontories. The higher levels must have been due to the damming action of the Sarfartok Glacier when more extensive, and which even now calves into the river just above the canyon. It is likely that for a considerable time the level was high enough to cause the main mass of the water from the lake to overflow into Evighed's Fjord, for, at the head of this latter valley, there is a gorge leading towards Evighed's Fjord, and this is now occupied by a stream, small out of all proportion to the width of the gorge. There is nothing in the topography to suggest that it should have been occupied by a large stream, other than one from the Tasersiak. This diversion of water from the Tasersiak may incidentally account for the recent appearance of the erosion of the lake terrace near the estuary, for Clearwater alone could have little erosive power.

Owing to the scanty vegetation the geological nature of the district is very clearly displayed, and in the area in which we worked very little variation was evident. The region, like the greater part of the west coast, is associated with the Archaean formations of north Canada, and the rock series consist almost entirely of gneisses, usually of a light greyish-brown colour, but there were variations from light grey to reddish-brown, according to presence or absence of ores—chiefly iron ore. The most striking feature of the district, and I believe a feature which is not general or widespread in any other part of the country, is the intrusive dolerite. Over the greater part of the country the basic rock was exposed, and its banded nature is evident in almost every scenic photograph. Dark veins of dolerite, running more or less parallel with one another, occurred throughout the whole region which was mapped (500 square miles), and extended as far as we could see beyond it. In parts there were minor variations of strike and in the angle of depression, but, generally speaking, the prevailing trend of the strike was E.N.E.–W.S.W., and the dip varied from a general average of 30° to 80° or 90°. There were also variations in the thickness and frequency of the intrusions. In the neighbourhood of the estuary they were close together and probably outcropped over one-tenth of the surface area, while in the direction of the Tasersiak they became gradually less frequent and outcropped as much as half a mile apart. In thickness the major intrusions varied from 50 feet to 80 feet. They appear to be only slightly more resistant to weathering than the gneiss in which they occur.

Such is the general geological nature of the district. No other types of rock were seen, with the exception of some isolated fragments of quartz and mica-schists. The general dip of the strata towards N.N.W. has resulted in a tendency towards the formation of escarpments with the steep slopes towards the S.S.E. These were particularly evident on the plateau (4100 feet high) between Last River and the Tasersiak, which consists of a series of scarped ridges about half a mile apart, and separated by valleys some 200–300 feet deep.

## APPENDIX III: TERRESTRIAL ECOLOGY

H. G. VEVERS

During the time that the Survey Party were in the Sarfartok District, the Biological Party spent five weeks in the Amerdloq Fjord and a month at Camp Lloyd in Sondre Strømfjord. The first camp was situated in the coastal mountainous region, the second in the continental hilly belt, about 24 miles from the Inland Ice. Both were in the same latitude, 67° N. The main object of the work on the land ecology was to follow up and extend the results of the Oxford Expedition in the Godthaab District (lat. 64·5° N.) in 1928, by means of detailed surveys in the maritime Arctic and continental regions; and if possible to obtain results on the relative numbers of Arthropods in the main habitats. Observations on the vegetation were carried on at the same time as the work on the animal relationships, and were intended to act as a background to the latter.

The camp in Amerdloq Fjord was 15 miles east of Holsteinsborg, and was therefore near the northern limit of the maritime Arctic climatic regime distinguished by Trapnell (1933). In spite of its proximity to the coast, during the time that we were there, sea-mists were only encountered on three days and rain on eleven, although we could often see a thick fog over the skerry-fence and outer coastal districts. Owing to the lack of pack-ice on this part of the coast, the relative humidity very seldom rose sharply and there was not the considerable lowering of insolation observed by Trapnell in the Godthaab District. Day temperatures were high during July, reaching a maximum of 29° C.

Together with the climate the most important environmental factors are physiographic. The neighbouring mountain ranges vary in height between 1000 and 2000 feet, with occasional peaks up to 4000 feet, and are intersected by a complicated system of lakes and moraine valleys. A considerable area is therefore either level or with only a small angle of slope; this enables a thicker snow cover to remain as a protection during the winter.

The general form of the vegetation is a heathland, varied locally by a number of different dominants. The factors responsible for this mosaic of associations are not at first apparent, but by means of intensive surveys it was possible to draw up an interconnecting scheme of their relationships. In the simplest type only crustaceous lichens are present, this condition being found on some moraines. More usually however the latter show interesting polygon formations, with plants of the dwarf birch (*Betula nana*) forming a polygon round a more luxuriant lichen mat. Apart from these types, essentially conditioned by the physiographic factors, the general heathland is characterized by an abundance of willow (*Salix glauca* and other species), birch (*Betula nana*), and crowberry (*Empetrum hermaphroditicum*). In slightly moister parts these are replaced by *Ledum*, and in marshes by cotton-grass (*Eriophorum*). On the mountains, patches of *Cassiope tetragonum* and other Ericaceae form mats, but these are very local in occurrence. The most interesting deviation from the general heath habitats is the willow scrub, which is found almost exclusively along the valleys of streams, where there is a thick snow cover in winter. In this district the average height is never more than 1 metre.

The bird fauna is similar to that described by Longstaff for the subcontinental region near Godthaab, but the density of Passerines is not so great as that observed by him. The snow bunting (*Plectrophenax nivalis subnivalis*) is almost entirely confined to the rocky ridges near the shore-line where it feeds; the wheatear (*Oenanthe oe. leucorhoa*) is abundant among the rocks on the mountain sides; and the Lapland bunting (*Calcarius lapponicus groenlandicus*) very common both on the general heathland and in willow scrub, nesting either

on hummocks or in the willow bushes. The Greenland redpoll (*Carduelis linaria rostrata*) is the most abundant of the Passerines, with a range of habitats almost the same as the Lapland bunting. Unlike Longstaff I did not find the redpoll nesting exclusively in the willow scrub. Ptarmigan (*Lagopus mutus*) were found among the rock domes between 1000 and 2000 feet, but never in great numbers. Ravens (*Corvus corax principalis*) are very common as residents, and a pair of Iceland falcons (*Falco rusticolus islandus*) were often seen hunting small birds in the neighbourhood of the camp. The great northern diver (*Colymbus immer*) and the mallard (*Anas platyrhyncha conboscas*) were very common on the tarns, and the long-tailed duck (*Clangula hyemalis*) and the eider duck (*Somateria m. mollissima*) were seen occasionally.

The first part of the work on the animal ecology consisted of a collection of insects and Arachnids, together with notes on their distribution and habits. With a view to obtaining results on the relative densities of Arctic Arthropods a series of sweep-net samples of the upper vegetation layers was taken. An attempt was also made to extract a representative population from the soil by means of a modified Berlese funnel. The sweep-net sample has shown clearly the actual density of mosquitoes (*Aëdes nigripes*) and Canadian black-flies (*Simulium vittatum*), while in a separate investigation the degree of activity of the mosquito under varying climatic conditions was studied.

On July 28 we returned to Holsteinsborg and spent a few days preparing for the expedition to the head of the Sondre Strømfjord, where we arrived at midnight on August 3. Here we were able to use Camp Lloyd, the base of the University of Michigan Greenland Expeditions. In spite of its having been deserted since 1928 Camp Lloyd is in very good condition, and through the kind permission of Professor Hobbs we were able to use the huts on the shore and the observatory on Mount Evans.

This part of the country is characteristic of the inland or continental belt; the climate is much drier than in the coastal regions, and the hills are low and undulating, and seldom exceed 1500 feet in height. During part of the year the warm föhn winds are common and precipitation is low. These factors have resulted in the development of a dry grassland in many parts, in addition to the associations making up the general heathland. In the more sheltered valleys there is an extreme development of willow scrub, where the willow bushes reach a height of 12 feet. The bird fauna is similar to that in the Amerdloq Fjord, with the addition of barnacle geese (*Branta leucopsis*) and Brent geese (*Branta b. bernicla*), which were frequently observed near the lakes, and of the red-necked phalarope (*Phalaropus lobatus*) which was seen on one occasion. The density of the Passerine species was somewhat lower than in our first locality. Surveys of the invertebrate fauna of this part were carried out in exactly the same way as described above. The willow scrub was again the most densely populated habitat, both in the upper layers of vegetation and among the moss and soil round the roots of the bushes, where an interesting fauna of mites, spiders, and springtails (*Collembola*) was found.

During an expedition inland to the ice cap the varied physiographic factors in the river valleys were seen to be responsible for the development of sand-dune vegetation in a few places, and of a rather unstable association of plants on the large silt-plains. These types were therefore very local. The general heathland habitat, on the other hand, was found continuously all the way up the ice itself, and with it the redpoll and Lapland bunting, which were extremely constant.

The collection of flowering plants, mosses, lichens, fungi, and mites has been deposited in the British Museum (Natural History); the insects have been

presented to the Hope Department, University Museum, Oxford; and the spiders have been deposited with Dr. A. R. Jackson, of Chester. A detailed account of the work on the land ecology will appear elsewhere, and will incorporate the results of the authorities who have undertaken the identification of the various groups of animals and plants.

## APPENDIX IV: MARINE ECOLOGY

D. M. Steven

The intertidal marine fauna of Greenland has been poorly investigated as yet, and consequently little is known of it. In recent years expeditions to the east coast have collected valuable material, and Madsen, who was with Lauge Koch from 1931 to 1934, has put forward some interesting problems especially those concerning the world distribution of Arctic marine forms. The only systematic description of this fauna on the west coast however is by Otto Fabricius, a Danish pastor in Greenland in the late eighteenth century, and though he left a very complete account of the species in his district, and is still the authority for certain identifications his methods in no way satisfy ecological needs. Consequently a general description of the faunas, habitats and conditions is necessary before attacking the problems raised by Madsen.

The area investigated was on the north shore of Amerdloq Fjord near Holsteinsborg at about latitude 66°–67° N., longitude 53° W., in the bay known to the Eskimos as Utorkait. The country is mountainous dropping steeply into the sea so that the shore is practically uniform, consisting mostly of smooth rock slabs, in some places more or less broken up into a boulder beach, in others perpendicular cliffs. Sandy beaches are rare and small, occurring mostly in the heads of bays and near stream mouths. Owing to the difficult nature of the country a series of collecting grounds for intensive study was chosen near the base camp, after a superficial examination of more widely separated sites had established the uniformity of the shore. We were fortunately situated in that within 200 or 300 yards of the camp there were three stretches of sandy beach, a stream mouth and all types of rocky shore. The number of species found in such a restricted habitat was surprisingly large, especially as there was no typical sand-inhabiting fauna whatsoever. This is probably due to the fact that sand beaches are so few and small, the grain of the sand so coarse and the winter ice-foot so destructive to life. However at one rock station between thirty and forty species were found, and what is more remarkable they showed a closely parallel series of types with the English fauna of a similar habitat. For instance there were about a dozen species of Molluscs, several Polychaetes, and two or three Oligochaete worms, a similar number of Nemertines and Turbellaria, Crustacea, two sea anemones, a hydroid, a Holothurian and a fish. Madsen by contrast found between latitudes 70° and 74° N. on the east coast only a few species of Polychaete, Turbellaria, Crustacea, and Nemertines; no Molluscs, Coelenterates or Echinoderms. Of course the conditions there are much more severe than at Holsteinsborg, and it was to be expected that this would be reflected in the richness of their respective faunas.

During the collecting period, which was roughly the month of July, several interesting problems arose. In the first place the effect of the winter ice-foot was very striking. Holsteinsborg is the most southerly district on the west coast where the sea ice is thick enough for dog sledging in winter, and an ice-foot of 1 to 2 metres thick forms more or less regularly in December and persists till May. Consequently the upper part of the beach is completely

bare of life in early summer and is only colonized later by the snail *Littorina saxatilis*, a few small barnacles and some terrestrial animals, such as springtails, spiders, mites, and fly larvae. The variations observed in the fauna near low-water mark may also be due to the melting of the ice, for several more species were present at the spring tides in the last week of July than at the corresponding ones in June, while certain other species had moved farther up the shore during that period. Our position was by no means ideal for investigating these problems. The amount of fresh water poured into the bay during the summer months introduced great variations with a general lowering of the salinity, and how far this affects the fauna is difficult to determine. Also the time was too short, as there were only two spring tides during the period. Observations should commence as soon as the ice begins to break up, and for that it would be necessary to winter out there. They should be continued right to the end of the summer, for though we had the peak of the hot weather in July, the shore fauna may increase until checked by the first frosts in September.

A further aspect which will be of interest when the identifications are completed is the composition of the fauna with reference to the world-wide areas of distribution. Not all the species are exclusively Arctic, some are American-Atlantic, others sub-Arctic, while only a few are true high Arctic forms.

The collections have been deposited with the British Museum, and I am indebted to the following, who are identifying them for me there: Captain A. K. Totton (Coelenterates), Dr. I. Gordon (Crustacea), Dr. H. A. Bayliss (Turbellaria and Nemertines), Dr. C. C. Munro (Polychaetes), Mr. G. I. Crawford (Mollusca), Mr. Dilwyn-John (Echinodermata), and Mr. J. R. Norman (fish). A full report will be published in due course on the results of their identifications.

## DISCUSSION

Before the paper the PRESIDENT (Professor HENRY BALFOUR) said: Mr. Peter Mott, who is going to lecture to us, was leader of the expedition to West Greenland under the auspices of the Oxford University Exploration Club. There was a previous expedition to the same general region in 1935, organized primarily for the purposes of survey and biological work. The venture led by Mr. Mott was an extension of what was done during the previous expedition. Various objectives were set out for the earlier expedition, some of which were not quite attained, although a considerable amount of valuable survey work was done in the region. In 1936 most of the objectives which had been marked out for survey work were accomplished in the most satisfactory manner, notably, as you will hear presently, the locating and exploration of a lake which had been reported in the region but which had never actually been seen by a scientific white man for the purpose of putting it on the map.

The party under Mr. Mott was divided into two sections. There was the main survey party under Mr. Mott and, in addition, a small biological section which remained down on the coast and conducted biological researches there.

I will not go into any detail because Mr. Mott is going to give the account of his own expedition and I will ask him if he will be so kind as to give us his paper.

*Mr. Mott then read the paper printed above, and a discussion followed.*

The PRESIDENT: Fortunately, some other members of the expedition are with us. I will ask Mr. Sugden if he will kindly tell us something about his part of the work. He was not only engaged in the biological work of the expedition but was also in charge of the health of the expedition, and the result was extremely satisfactory.

Mr. J. C. G. SUGDEN described the geology of the region (see Appendix II). He continued: There was no medical work for me to do, except that in the last week or two members of the party began to develop slight toothache. They were however unwilling to let me touch them. Otherwise, the food was so excellent and the arrangements so perfect that we had no trouble whatever.

Mr. H. G. VEVERS and Mr. D. STEVEN then gave an account of the biological work of the expedition (see Appendices III and IV).

The PRESIDENT: Mr. Wordie is one of our best-known Arctic explorers. I will ask him to add to the discussion.

Mr. J. M. WORDIE: It is a great pleasure to me, as one coming from Cambridge University, to congratulate the Oxford Exploration Club on yet another successful expedition. I feel I have been asked here to speak perhaps as a kind of sacrifice, to stand up and confess the weakness of Cambridge; certainly there are few of us who could have put through an expedition so successfully as Mr. Mott did last summer. He has described travel through a region in Greenland which is one of the most difficult to penetrate, and that is the reason why this area, so near to the inhabited part of Greenland, has remained practically unexplored. It is comparatively easy to cross the Ice Cap or to get about on level ground in the Arctic where there are no streams and lakes; but when there is a combination of ice caps and large rivers draining to the coast you never know what hidden obstacles may arise. An expedition, as Mr. Mott indicated on the map, may be going ahead very well for a time, and suddenly trouble develops owing to a deep gorge intervening; or swamps where rivers spread out before reaching the sea; or a broad and swiftly flowing torrent. In the circumstances, Mr. Mott seems to have covered a great deal of ground. My own feeling on listening to him to-night is one of admiration of the way in which he got himself across that ground at all costs. I am not surprised also to learn that another expedition is planned to go out again to much the same region. There is a great amount still to do, particularly in connection with the geology. Mr. Mott's expedition discovered many geological features of interest, but only a few have been described to-night; and there is still more survey to be done. One hopes that others will go out again in 1938, and that they will meet with the same satisfying success as did Mr. Mott and his party last year.

The PRESIDENT: The evening is getting late and I am afraid I must bring the discussion to a close. I think we can all feel assured that this latest expedition on the part of the Oxford Exploration Club has been worth while. They have attained their objectives, done an excellent piece of survey work, combined with other scientific observations, and they are to be congratulated on having brought off a most successful expedition.

On the last occasion when we met and when we were dealing with the other side of Greenland I mentioned, in order to reassure you a little, that the two sides of Greenland are extremely different the one from the other. Those who have been at both lectures will have had brought home to them the fact that there is a very considerable difference between the east and west coasts of that vast area. Therefore I do not think it has been a serious matter that we should on two successive evenings have concentrated on the same general region. In fact, some of us will probably leave this hall with quite a new idea of Greenland. The fact that a temperature of 90° F. can be recorded there, and has been by this expedition, is really an eye-opener. Personally, I had an idea that the temperature in Greenland never rose above 80° F., and even then that that was looked upon as something quite extreme.

Mr. Wordie has made very kind remarks indeed in regard to the expedition. I am sure that the Oxford Exploration Club will be very gratified by what he

has said. The Club is a most energetic one and has already sent a succession of expeditions to Greenland. In the course of them a large area of that country has now been mapped with very fair accuracy.

We certainly owe to the Danish authorities an immense debt of gratitude for the constant help they have given to expeditions such as that about which we have heard to-night. I can only hope that the surveys which result from them and the scientific work which is done during the expeditions will be regarded as of sufficient recompense to the Danes. They have been exceedingly kind all through; they have welcomed our expeditions and done everything they possibly could to promote their welfare. I would like to place that on record and draw attention to the fact that every kindness has been shown throughout. You may be certain that Mr. Mott and his colleagues would be the first to say how much they owe to the courteous help of the Danish people, not only at headquarters in Copenhagen but also to those who administer affairs in Greenland.

I am going to ask you to express your thanks to Mr. Mott for a very interesting description, given in a most attractive manner, of the topographical features which he and his party have placed on the map and have surveyed with very great effect. I ask you to convey to him a hearty vote of thanks.

# THE GEOMORPHOLOGY OF THE SOUTH-WEST LANCASHIRE COAST-LINE

R. KAY GRESSWELL

BETWEEN Southport and Liverpool there stretches a continuous area of blown sand, varying in width up to a maximum of $2\frac{1}{2}$ miles from its eastern margin to high-water mark at Formby, the total area of the deposit above high-water mark being about $23\frac{1}{2}$ square miles. Before settlement, the whole of the surface was sand dunes, but much of the sand belt has been built upon, mostly during the last hundred years, and many of the hills have been levelled. Southport (pop. 78,927 in 1931), near its northern extremity, is a dormitory-town for the industrial region of south-east Lancashire and the Liverpool area. The other settlements are almost exclusively dormitory-towns for the Liverpool area only. They are Birkdale and Ainsdale, which are continuous with Southport, Freshfield and Formby (pop. 7957), Hightown, Blundellsands, Great Crosby, Waterloo, Seaforth and Bootle. The last five are continuous with Liverpool, the last being mainly industrial.

The Land Utilization Survey map (sheet 35) shows that very little of the sand area is arable. Nearly the whole is occupied by the sand dunes, the settlements just referred to, and golf courses. There is a little permanent grass. From very early times it was customary to plant star-grass (=marram), *Psamma arenaria*, Beauv., to prevent the sand from being blown inland. Wherever this has not been done, there has been an inland spread of the blown sand over previously fertile land, as at Formby and Birkdale. Behind the front complex ridge of dunes there is a large variety of plants, but star-grass, pines, of which several square miles have been planted, principally between Woodvale and Formby, and creeping willow, *Salix repens*, Linn., are the chief sand-binders.

*The present coast-line*

From Preston to Marshside, just north of Southport, the coast forms the southern bank of the Ribble estuary and consists of marshes with a muddy foreshore. About Marshside the influence of the Irish Sea begins to predominate, and from Marshside to Southport the coast is a transitional one. In common with parts further north, much reclamation has been accomplished here during the last century by the building of embankments, after sods of marsh grass, locally termed "saltings," have been planted on the open beach about 6 feet apart and allowed to spread, join up, and raise the level of the foreshore by trapping the mud in suspension in the water which covers them at full tide. North of Southport Promenade, the old sand cliff, the coast-line of the 1845 O.S. 6-inch plan, is now over 2500 feet inland of the most seaward embankment. Between Marshside and Southport, the sand of the beach contains an admixture of mud, which is sufficient to prevent it from drying and being picked up by the wind. Thus there are no sand dunes north of Southport. Very little mud is found south of Southport Pier, and a line from the Pier Head to the Promenade in a westerly direction roughly marks the present northern limit of blowing sand. From Southport Pier to Liverpool

Docks, except for the presence of Grey Clay and Peat outcrops at certain places, the shore consists of pure sand with a total absence of shingle and outcropping rocks. Except where there are promenades or walls, the coast-line consists of sand dunes, probably averaging about 20 to 30 feet in height throughout the whole length, but rising in places to 50 feet, notably midway between Birkdale and Ainsdale, at Formby point, and north of Blundellsands.

Owing to the great tidal range (about 30 feet at springs), the foreshore is everywhere very wide, as will be apparent when changes in its width are discussed later. A profile across the foreshore from the dunes to low-water mark shows a wave-like form caused by a number of undulations (from three to five) on its surface, whose crests I have named "fulls" and troughs, "lows." The wave-length of these undulations is usually about 500 feet and the amplitude between 3 and 5 feet. They lie parallel to one another and to the coast-line from Freshfield to Formby point, where this faces west, but north of Freshfield they incline away from the coast-line northwards. South of Formby point, they similarly incline away from the coast-line southwards, but south of Hightown they are not so well developed owing to the presence of the river Alt on the foreshore. These fulls and lows are permanent features of the foreshore, and any particular full is continuous from where it appears from below l.w.m. at, say, Ainsdale, to where it merges with and disappears into the backshore, say, 2 miles further towards Freshfield.

So far as I am aware, sand fulls and lows such as these have merely been referred to in scientific literature, although they appear to be developed, to a much less extent, on most sandy foreshores, and somewhat similar profiles also occur in shingle foreshores. In 1898, Vaughan Cornish described[1] a somewhat similar phenomenon occurring at high-water mark and named it a "full," from which I have adopted the name. In 1919, D. W. Johnson,[2] without specifically defining beach ridges, stated that they "are known to the English as 'fulls'," but in the following pages (404–452) he seems normally to imply by "beach ridge," a ridge landward of h.w.m. Cornish further referred to a similar structure,[3] apparently occurring below l.w.m., by the name of "ball," a term used in the same sense by Johnson (pages 486–489), but neither dealt with any intervening undulations, such as I have found to occur. I suggest that the three terms be defined as follows:

Beaches often show marked undulations of considerable wave-length and low amplitude, lying parallel to each other but often at an angle to the coast-line. Those undulations which occur on the shoreface, *i.e.* below l.w.m., are termed "balls"; those on the foreshore, *i.e.* between l.w.m. and h.w.m., are termed "fulls"; and those on the backshore, *i.e.* between h.w.m. and the coast-line, are termed "beach ridges" or "ridges." There may be one or more of each of these features on a particular shore. The word "shingle" or "sand" can be prefixed to these terms as necessary. Natural drainage channels which cross a full, taking the tidal water from one low to the next seaward, should be called "cross-lows." This clarifies the meaning of balls and beach ridges, and gives a definite interpretation to the word "fulls."

[1] *Geogr. J.* 11 (1898) 637.
[2] D. W. Johnson, 'Shore processes and shoreline development,' p. 404.
[3] *Geogr. J.* 11 (1898) 637.

Miles
1 0 1 2 3 4
Measuring lines (with positions and bearings)
N
Pier
Marshside
Churchtown
SOUTHPORT
L.W.M.O.T.
H.W.M.O.T.
Birkdale
Inland boundary of blown sand
N. Ainsdale
(53°37'N. 3°3'W.)
(W.29°N.)
S. Ainsdale
(53°36'N. 3°4'W.)
(W.29°N.)
Woodvale
(53°35'N. 3°5'W.)
(W.34°5'N.)
Dale Slack
Freshfield
(53°34'N. 3°6'W.)
(W.20°N.)
Victoria Rd
Formby
Formby Pt.
(West)
(53°33'N. 3°6'W.)
S. Formby Pt.
(53°33'N. 3°6'W.)
(W.42°S.)
R. Alt
Altcar Rifle Range
(53°32'N. 3°4'W.)
(W.23°S.)
Formby Channel
Taylor's Bank
Revetment wall
Queen's Channel
Crosby Channel
S. Hightown
(53°31'N. 3°3'W.)
(West)
Formby Bank
Revetment wall
N. Blundellsands
(53°30'N. 3°3'W.) (W.20°S.)
Great Crosby
S. Blundellsands
(53°29'N. 3°2'W.) (W.39°S.)
Litherland
Waterloo with
Seaforth
(53°28'N. 3°1'W.)
(W.39°S.)
Burbo Bank
Rock Channel
Bootle
Bankhall
Docks
River Mersey
Wirral
LIVERPOOL

These features are being investigated, by regularly surveyed profiles and other means, to discover the mechanism of their formation. I have found that they attempt to face the dominant waves and are almost certainly formed by waves of moderate size rather than by storm-waves.

Returning to the coast-line, between Birkdale and Woodvale, the line of dunes fronting the shore is in a more or less stable condition, neither erosion nor accretion due to blowing sand occurring. About Ainsdale however, owing to the many thousands of day visitors, the considerable trampling to which the star-grass and the hills are subjected has, during the last five years, caused a general lowering in the level of the hills.

On the backshore, between Ainsdale and Woodvale, a belt of grass, *Poa maritima* Huds., about 130 yards wide, divided into three parallel belts by narrow roads of bare sand, and nearly $1\frac{1}{2}$ miles in length, grew on the beach, commencing in the summer of 1932 with the portion nearest the dunes and gradually spreading to its full width by the midsummer of 1933. The grass was patchy, and in consequence the blowing sand from the beach was unevenly trapped by the grass, making the surface of the ground very irregular. The seaward edge of the grass in 1933 is shown in the illustration. The summer of 1933 and the winter of 1933–34 were periods of exceptional drought, and this had a profound effect on these bands of grass, for this portion of the backshore is above the reach of all but storm tides. Early in the autumn of 1933 the grass was entirely covered by a thin layer of blown sand from the foreshore, and owing to the absence of rain during the ensuing months the grass failed to grow up through the sand covering. During the winter, other windstorms brought additional sand, which not only filled the hollows between the hummocks that had covered the area, but also added more sand over the grass itself. The vegetation thus entirely disappeared under a covering that was probably about 4 to 6 inches in thickness. The drought continued into the summer of 1934 and the grass has apparently died. During the winter months preceding the first appearance of this sudden growth, the backshore, owing to the gradient being practically zero, became logged with rainwater, and it is possible that, owing to the raising in the level of the beach by the sand-collecting powers of the grass, the backshore then drained sufficiently well to prevent the growth of marsh grass from 1933 to 1937.

Incidentally, with regard to the backshore becoming logged with rainwater, I have constantly found that the beach dries very much more slowly after being wet with rain or with freshwater, which in the winter months is drained through the sand dunes in pipes at several places from the land behind, than when it has been covered with the sea itself at full tide.

At Woodvale boundary,[1] as motor cars are allowed on the shore, two notice boards were erected in 1928, containing the byelaws and a speed-limit warning, about 50 feet in front of the dunes. Regular measurements have been taken of the height of the underside of one of these boards above the sand, starting in July 1933, when the height was $63\frac{1}{4}$ inches (see illustration). By December

[1] Actually this is the boundary between Southport and Formby, but the district about here on both sides of the boundary is usually known as Woodvale, an undefined area. Similarly, the northern part of Formby is known as Freshfield, the use of the name Formby being confined to the southern part of the administrative area.

*A swale near Woodvale*

*New dunes at notice-boards, Woodvale, June 1933*

*The dunes at notice-boards, Woodvale, October 1935*

*Erosion of sand dunes at Freshfield*

*Burbo Bank Road North: tin-slag protection*

*The river Alt at low tide, north of Blundellsands*

it was 50 inches, and by May 1934, $28\frac{1}{4}$ inches. By December it had increased again to $34\frac{3}{4}$ inches, by May 1935 it was $27\frac{1}{2}$ inches, by October it was $5\frac{1}{2}$ inches (see illustration), although by April 1936 it had increased again to 19 inches. When it is remembered that in 1928 the boards were on the level beach, some 50 feet seaward of the foot of the dunes, the photographs illustrate the great accumulation of sand around them, and their presence shows the rate at which dunes can accumulate naturally. At the crest of the new dunes the rise in level in the eight years 1928–1936 is probably about 10 feet. Their width at Woodvale boundary is 97 feet, with 28 feet of short grass in front, and the notice boards have now been moved in front of them. These new dunes commence about $\frac{1}{4}$ mile north of the Woodvale boundary and continue without interruption until $\frac{3}{4}$ mile south of that point. Here a footpath comes out on to the beach. They continue southward, but begin to merge more and more with the general line of the hills and, decreasing in size, at $1\frac{1}{4}$ miles south of the boundary they are indistinguishable from the main hills themselves.

From Birkdale to Woodvale the dunes form a tangled mass with no definite pattern. From just north of the boundary at Woodvale however the dunes near the shore are arranged in several distinct ridges with broad swales between, which continue practically unbroken for approximately 2 miles to Freshfield. These have been caused by the artificial encouragement of their growth during the early part of the present century. Brushwood was set up in lines on the sandy shore, close to the dunes, taking up strips of frontage of from 10 to 20 feet at a time, star-grass usually being planted behind. Willows proved the best brushwood and were planted $1\frac{1}{2}$ to 2 feet deep in the sand.[1]

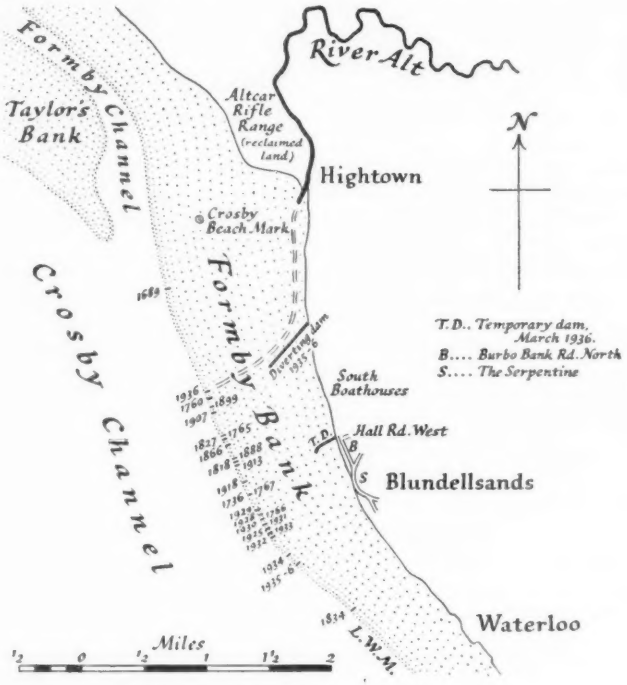
In June 1936 a line of measurement was taken from an iron boundary post on the open beach at Woodvale, in a direction bearing E. 30° S. (at right-angles to the coast), which may be useful for future reference, as well as showing the magnitude of the dune ridges and their intervening swales.

| | *Feet* | |
|---|---|---|
| Boundary post .. .. .. | 0 | |
| Seaward edge of 1936 short star-grass | 347 | |
| New dunes, seaward edge .. .. | 375 | Width of gain from foreshore, 1928–1936=97 feet |
| Dunes as in 1928, seaward edge .. | 472 | |
| ,, crest .. .. | 503 | Width of dune ridge 79 feet |
| ,, back .. .. | 551 | |
| Swale 80 feet in width | | |
| Second dune ridge, front .. .. | 631 | |
| ,, crest .. .. | 660 | Width of dune ridge 56 feet |
| ,, back .. .. | 687 | |
| No swale | | |
| Third dune ridge, front .. .. | 687 | |
| ,, crest .. .. | 708 | Width of dune ridge 75 feet |
| ,, back .. .. | 762 | |

Further inland the dunes are a tangled mass and not arranged in ridges. As

[1] Report of the Royal Commission on Coast Erosion, 3rd report, 1911, p. 268.

already stated, the new dunes are natural, but the ridges are the result of artificial encouragement. The second ridge does not continue far south from Woodvale. The height above the beach of this same boundary post has been measured regularly since 1933. In July of that year, it projected $53\frac{1}{2}$ inches above the sand, and, increasing by more or less regular amounts, but with occasional set-backs, it projected 56 inches in July 1936. This presumably will be a genuine lowering of the beach level, for it is unlikely that the post is slowly rising. It stands just below h.w.m. springs. The measurement has been the sloping height up the west side of the post to the top of the metal




*Migrations of mouth of river Alt*

portion, the wooden plug not being included. Any ripples or local hollow round the post have been allowed for.

Erosion of the sand dunes by the sea commences about a quarter of a mile north of Victoria Road, Freshfield, and continues to Formby point. The rapidity and causes of this erosion are referred to in the latter part of this paper. The dunes are no longer arranged in any definite pattern, and, except at Victoria Road, where they have been practically destroyed by visitors, are of medium height. At Formby point, bordering the beach, there is a single range which rises to a height of 50 feet, descending on the landward side to

a fairly level area about 20 feet above the backshore. As soon as Formby Point is passed, erosion ceases, and, in fact, slight accretion has occurred in recent years, following rapid accretion throughout the last century. The remainder of the coast towards the river Alt is occupied by the Altcar Rifle Range and the condition of the dunes in this area very plainly reflects the absence of trampling.

The river Alt enters the beach at Hightown, but until the erection of dams in 1936 only entered the sea, or more correctly the Crosby channel of the river Mersey, $2\frac{1}{2}$ miles nearer to Liverpool. The river meandered along the foreshore with a general course parallel to the dunes, making no attempt to turn seaward until it reached Blundellsands. Except fairly near to Hightown, erosion has occurred throughout this length for the last 140 years at least,[1] and to prevent this from continuing, two dams of tin-slag were constructed in 1935–1936 across the shore from the dunes almost to l.w.m., one opposite Hall Road West and the other midway between Hightown and Blundellsands. The former was brought into operation in March 1936 and was intended as a temporary measure to keep the Alt off the more vulnerable part of Blundellsands until the larger work was completed and the river entirely removed from the vicinity.

Forming the surface inland of the sand belt, and probably underlying the whole of it, there is a thick belt of peat, always with the stools and fallen trunks of trees, chiefly oak and silver birch, at the bottom. This bed outcrops on the beach from under the sand dunes between Hightown and Blundellsands, forming a submerged forest. Previously it outcropped more or less continuously from Formby to Liverpool, but at Formby and south of Blundellsands only the underlying Grey Clay is now to be seen. These beds have been correlated with similar ones on the north coast of the Wirral across the Mersey and fully described by C. B. Travis.[2]

Beyond the point where the river Alt entered the sea, erosion ceases and the coast-line appears to be in a state of equilibrium. Owing to the proximity of Liverpool, the whole of the hinterland bordering the coast from Blundellsands to Liverpool is entirely built up, and although in several parts there still remains a single row of dunes facing the beach, much of the remaining coast-line to the docks is formed by garden boundary walls and promenades.

*Changes prior to* 1845

No detailed information is obtainable concerning this coast-line until the surveys of the sixteenth century. The district was a wilderness of sand dunes and undrained "moss" (the peat belt), and consequently it did not attract settlement until a fairly late date.

From a detailed analysis of all the available map evidence prior to the first Ordnance Survey survey in 1845, and after making full allowance for the inaccuracies of the early cartographers, I conclude:

(1) There was a bay south of Meales (now called Churchtown) during the sixteenth and seventeenth centuries.

[1] See illustration to letter in *Gentleman's Mag.*, July 1796, pp. 549–551.

[2] "The peat and forest bed of the s.w. Lancashire coast," *Proc. Liverpool Geol. Soc.*, vol. xiv, 1926, pp. 263–277; and "The peat and forest beds of Leasowe, Cheshire," *Proc. Liverpool Geol. Soc.*, vol. xv, 1929, pp. 157–178.

(2) Sand banks were in existence and were fully developed to their present extent by 1689,[1] including in the Ribble estuary and opposite Southport, although their form has varied considerably from time to time. The map by Greenville Collins is the first to show the banks in any detail. Thus there has been a sandy beach and dunes have existed for at least several centuries, and there is no reason to suppose that they have not been present for a much longer time. There is no evidence to show whether the inland spread of blown sand is of recent date or not.

(3) There was a bay on the Lancashire coast of the Mersey at Litherland and Bankhall in 1598,[2] which filled in before 1689,[1] although the Mersey was then probably still narrower at Liverpool than at Bankhall, the contrary being now the case.

(4) The river Alt has flowed in a southerly direction across the beach since the first surveys which marked both high- and low-water mark (1689),[1] having previously been as far south as it was until dammed in 1936.

(5) The main channel of the Mersey, the Rock channel and the Burbo system of banks, were all well established as features at the time of the first maps which showed the outlines of the banks (Collins, 1689).

(6) The present Formby channel, with the triangular bank (now called Taylor's bank) off Formby point, became established before 1765 (map by Emanuel Bowen).

*Changes since* 1845

With a succession of surveys and revisions on the same large scale of 6 inches to the mile provided by the four editions of the Ordnance Survey plans of this district, it is possible to make more precise comparisons and in consequence to study the changes in more detail.

Between Southport and Seaforth, there are very few features within a mile or more of the coast-line that have remained unchanged since the time of the first survey, in 1845. Owing to the nature of the area, there are no permanent natural features from which comparative measurements can be made over a long period, and the houses are quite recent. So, especially in order to keep lines of measurements as short as possible, I found it best to measure off the O.S. plans from arbitrary points defined by longitude and latitude at intervals of 1′, the lines always being taken at right-angles to the coast-line. From the origin of each of these lines, I have measured the distances of the seaward edge of the dunes for each edition, and of the h.w.m. and l.w.m. in the last three editions. In the first edition, the h.w.m. and l.w.m. were for spring tides, and are thus not comparable with the same lines on the three revisions, for these were all for particular ordinary tides, midway between springs and neaps. These are thus roughly comparable, but when differences are small they do not certainly indicate slight advance or recession of the water-line.

All measures are given to the nearest 20 feet; shrinkage of paper does not allow greater accuracy.

[1] Map dated 1689, being Plate 29 of 'Great Britain's coasting pilot,' by Greenville Collins, published 1693.

[2] Map of Lancashire in 'The Visitacion of Lancashire, etc., made in 1567,' Brit. Mus., Harl. 6159, fol. 2. This should be compared with the Saxton county map of Lancashire. All the maps of this period show these bays.

TABLE I: Distances from the origins on first survey and displacements, reckoned positive towards the sea, from later surveys.

| | *Seaward face of Dunes* | | | | *H.W.M.O.T.* | | | *L.W.M.O.T.* | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1845 | 1892 | 1906 | 1925 | 1892 | 1906 | 1925 | 1892 | 1906 | 1925 |
| North Ainsdale | +80 | +320 | +240 | +340 | +1020 | −60 | −340 | +3860 | −260 | −440 |
| South Ainsdale | −160 | +260 | +280 | +300 | + 680 | −200 | +100 | +3580 | −40 | −240 |
| Woodvale .. | −260 | +380 | +520 | +740 | +1080 | −300 | +160 | +4640 | −520 | −1000 |
| Freshfield .. | +220 | +400 | +670 | +620 | +1720 | −700 | −720 | +3660 | −300 | −860 |
| Formby point | +1020 | +560 | +720 | +280 | +2400 | −480 | −980 | +4040 | +240 | +1240 |
| South Formby point .. | +660 | +160 | +340 | +400 | +2040 | −940 | −720 | +3940 | +240 | +300 |
| Rifle range .. | +2000 | +280 | +380 | +420 | +3640 | −40 | −140 | +6500 | −900 | −420 |
| South Hightown .. | +2900 | −140 | −200 | −280 | +2980 | −120 | −200 | +11130 | −2110 | −2390 |
| N. Blundellsands .. | +1900 | +100 | +120 | −240 | +2620 | −400 | −820 | +5800 | −200 | −880 |
| S. Blundellsands .. | +1900 | +180 | +180 | +160 | +2880 | +260 | +160 | +5180 | +200 | +180 |
| Seaforth .. | +930 | −70 | −70 | −70 | +1340 | +240 | +300 | +3680 | +20 | 0 |

The dates of individual sheets vary a year or two from the dates given above as the epochs of the original survey and revisions.

Table I shows that erosion of the seaward face of the dunes has been continuous throughout the period only at south Hightown, where it has been steady or slightly increasing. It has so continued since 1925, probably at about the same rate. Slight erosion occurred at Seaforth between 1845 and 1892, but this was small in amount and of little consequence. Erosion also occurred at north Ainsdale between 1892 and 1906, but, the lost width of dunes having now been regained, it appears to have been due to local causes which have since been removed.

The greatest accretion occurred until 1906 at Freshfield and Formby, although this was due to artificial encouragement, by planting brushwood in lines in front of the dunes, to catch fresh-blown sand. As the sand accumulated, star-grass was planted and the new dunes were thus anchored and further growth encouraged. The fact however that the dunes could accumulate in this way shows that the conditions were at least not unfavourable to their growth, and it is probable that some accretion would have occurred naturally, had the artificial stimulus not been supplied. Just at those points where accretion has been greatest, there is now rapid erosion. Gains of 12 and 11 feet per year at Formby point have been turned into losses of 23 feet a year, and my own surveys in this area show that from 1925 to 1934 the rate was 25 feet a year, and from 1934 to 1936, 66 feet a year. The erosion at south Hightown has now spread southwards to Blundellsands, being especially rapid at north Blundellsands.

Opposite the Serpentine and Burbo Bank Road North at Blundellsands, as the plan shows, eight large houses have had to be demolished and the extensive grounds of seven of them have been washed into the sea. This occurred between 1920 and 1928. Since 1930, tin-slag, from a Bootle works, has been tipped over the sand cliff formed by the erosion and has been very successful, although severe storms from time to time have moved the slag, which formed the facing to the upper portion of the cliff, to the lower part, thus making it

necessary to dump additional material. Except for the drifting of a certain amount of the material southwards, referred to later, no slag has been scattered about the beach or otherwise moved from the main body of the material by the action of the waves. It is heavy (about 218 lb. per cubic foot), and although the pieces are in no way held together, they seem to remain more or less where they are placed. Their sizes range from powder to blocks 6 or 7 feet in length, but by far the majority are from about 3 inches to 9 inches in diameter.

Table I also shows that in the majority of cases both the h.w.m. and the l.w.m. have moved eastwards. At south Formby point and the Rifle range the l.w.m. is formed by the bank of Formby channel and seaward of this there is Taylor's bank, so that changes in this l.w.m. indicate, not erosion, but a shifting of the channel. At Formby point itself however the l.w.m. faces the open sea. From south Hightown to Seaforth the l.w.m. forms the bank of Crosby channel, the main Mersey channel, and westward of this there is the Burbo bank system.

TABLE II: Width in feet of the backshore (foot of dunes to h.w.m.o.t.) and of foreshore (h.w.m.o.t. to l.w.m.o.t.) and change between 1892 and 1905

| | *Backshore* | | | *Foreshore* | | | *Change* | |
|---|---|---|---|---|---|---|---|---|
| | 1892 | 1906 | 1925 | 1892 | 1906 | 1925 | *Back-shore* | *Fore-shore* |
| North Ainsdale .. | 620 | 640 | 260 | 2840 | 2640 | 2740 | −360 | −100 |
| South Ainsdale .. | 580 | 360 | 640 | 2900 | 3060 | 2560 | +60 | −340 |
| Woodvale .. .. | 960 | 520 | 760 | 3560 | 3340 | 2400 | −200 | −1160 |
| Freshfield .. .. | 1100 | 130 | 160 | 1940 | 2340 | 1800 | −940 | −140 |
| Formby point .. | 820 | 180 | 120 | 1640 | 2360 | 3860 | −700 | +2220 |
| S. Formby point .. | 1220 | 100 | 260 | 1900 | 3080 | 2920 | −960 | +1020 |
| Rifle range .. | 1360 | 1220 | 1080 | 2860 | 1800 | 2580 | −280 | −280 |
| S. Hightown .. | 220 | 160 | 160 | 8150 | 6160 | 5960 | −60 | −2190 |
| N. Blundellsands .. | 620 | 200 | 140 | 3180 | 3380 | 3120 | −480 | −60 |
| S. Blundellsands .. | 800 | 1060 | 980 | 2300 | 2240 | 2320 | +180 | +20 |
| Seaforth .. .. | 480 | 720 | 780 | 2340 | 2120 | 2040 | +300 | −300 |
| Averages .. | 798 | 481 | 485 | 3055 | 2956 | 2936 | — | — |

The width of the backshore, which is given for the last three editions of the 6-inch plan in Table II, when due consideration has been given to the gradient of the beach, gives an indication of the level of the beach. For example, the change at north Ainsdale from a width of 640 feet to one of 260 feet, while during the same period the width of the foreshore had scarcely changed (thus showing that the gradient of the beach is substantially unaltered), indicates that at south Ainsdale there was a considerable lowering in the level of the beach between 1906 and 1925. This reasoning makes the assumption that if the gradient of the foreshore is unchanged, that of the backshore will be unchanged also. This usually is the case, both parts of the shore normally having approximately the same gradient on the coast under discussion. The most important and significant changes in the width of the backshore have occurred in a group at Freshfield, Formby point and south Formby point, and also at north Blundellsands, which are just those localities where accretion has been turned into erosion. In addition, the width has been narrow throughout the period at south Hightown, which is the only locality where continuous erosion has been recorded.

These facts illustrate a point of fundamental importance, namely, whether or not erosion of the coast-line will occur depends upon the level of the backshore, and is not greatly, if at all, dependent upon the width (and therefore the gradient) of the foreshore. When, as in this case, the backshore is measured from mean, or ordinary, high-water mark to the coast-line, a narrow backshore almost certainly indicates that spring and storm tides will reach the coast-line itself. If there is no backshore or if it is very narrow, then there will often be water of considerable depth up to the coast-line, and large waves will be able to break directly against it instead of having their energy dissipated on the foreshore. All erosion on the coast between Southport and Liverpool occurs during westerly storms which coincide with high water. It is of course obvious that in a coast such as this, when the coast-line is merely a line of sand dunes, erosion occurs whenever the water-line reaches the coast-line. It is reasonably certain that a very steep gradient would cause erosion, equally as a low backshore does, but such a gradient has not occurred here. On other coasts, the level of the backshore will always be the factor determining whether erosion will occur. The rate of the erosion will naturally be influenced by other factors, such as, direction and magnitude of the approaching waves, frequency of storms, nature of the coast-line, etc.

*Dominant winds and wave direction*

Since the arrival of waves oblique to a shore-line produces a longshore drifting of sand, it is desirable to know in what direction they normally come when meeting a particular coast, in this case the south-west Lancashire coast.

Hours of duration of wind in various directions, reduced to a percentage, for each month of the year and for the whole year, obtained by averaging the results of thirty years, are available for the Southport area, and are as follows (the direction of the wind is followed by the percentage duration per annum): north, 7; north-east, 7; east, 12; south-east, 16; south, 11; south-west, 13; west, 20; north-west, 14.

These figures take no account of the velocity of the wind. They thus do not indicate quantity of wind. Generally, the north-west, west, and south-west winds are the strongest, gales almost always being from the west, so that the predominance possessed by hours by winds from these directions would be further emphasized if the figures indicated true quantities.

Of the winds acting on the south-west Lancashire coast to produce waves and to blow inland the dried sand of the foreshore and backshore, that is, the north, north-west, west, south-west, and south winds, the west wind is the greatest or equal to the greatest in every month, and in almost every month there is a progressive falling off in duration of wind as the direction becomes less westerly. It should be observed that the north-east, east, and south-east winds have little effect on this coast, owing to their direction.

The size of a wave, and consequently its power as a geomorphological agent, depends not only on the strength of the wind, but also, and very largely, on the length of fetch, that is, the number of miles run, along which the wind can act upon it. An examination of a map of the Irish Sea shows that a much greater length of fetch occurs from a west direction than any other on to the south-west Lancashire coast, owing to the obstruction of Anglesey and the

north Wales coast on the south-west, and to the Isle of Man and the Blackpool promontory on the north-west and north. Consequently, apart altogether from wind-frequencies, it would be apparent that the most powerful waves must come from the west.

Since the greatest length of fetch, the direction of the dominating (by duration) wind, and the direction of storm winds all coincide, there can be no doubt that the wave-control of the south-west Lancashire coast acts from a westerly direction. The direction in which the fulls and lows lie along the foreshore quite clearly indicates the dominating effect of the westerly waves. W. V. Lewis [1] has shown that shingle ridges tend to be built in a direction facing the approach of the dominant waves, and although the mechanism of the building of sand fulls is not necessarily the same as that of shingle fulls and shingle beach ridges, yet it will be seen that everywhere on this portion of the coast-line the fulls are facing, or attempting to face, west.

The fact that, except at Formby, the fulls are not parallel to the coast-line shows that the waves do not suffer complete refraction, but still arrive on the foreshore obliquely. That they are parallel to the coast-line at Formby shows that the waves there arrive normal to the coast-line. The swash of each wave after breaking will therefore, north of Formby, carry the sand with which it is laden more or less due east, although the coast-line lies due south-south-west and north-north-east. The backwash will carry the grains directly down the steepest slope where it is steep, probably in a direction due west-north-west. The foreshore is sufficiently steep for this to occur only on the seaward face of the fulls. In other parts of the foreshore, where it is less steep, the backwash carries the grains, I have found, in a direction as though it were the reflection of the swash, the water-line acting as the mirror. Between Formby and Southport, this direction is due north-west. Thus each time a particular sand grain is picked up by the swash or the movement of waves in shallow water, between Formby and Southport, it will be carried by a zig-zag path a little towards Southport. The same process will carry the sand of the foreshore between Formby and Seaforth towards Seaforth.

From the conclusion that the dominating wave direction of approach to this coast is west, it may thus be inferred that foreshore drifting occurs away from Formby point in both directions, north-north-east towards Southport and south-south-east towards Liverpool.

There are no groynes to arrest the longshore movement of sand anywhere between Southport and Liverpool, and the existence of longshore drift cannot therefore be shown by the relative levels of sand on the two sides of the groynes. Two confirmations of the accuracy of the above inferential conclusion are afforded however (1) by the fact that the level of the beach on the Ainsdale side of the remains of the *Henry J. Smith* wreck, which is just north of Victoria Road, Freshfield, and which, lying across the beach, acts as a short groyne, is always lower than it is on the Freshfield side, thus indicating a foreshore drifting in the north-north-east direction as previously stated; and (2) by the fact that the only transportation effected by the waves on the loose tin-slag facing of the eroded sand cliff at Blundellsands has been to carry

[1] W. V. Lewis, "The effect of wave incidence on the configuration of a shingle beach," *Geogr. J.*, 78 (1931) 129–148.

it towards Seaforth, thus indicating a foreshore drifting in the south-south-east direction as previously stated. No previous worker has discussed foreshore drifting in this area, and my conclusions were first announced to the members of the Liverpool Geological Society on 12 November 1935.

*Causes of the erosion at Hightown and Blundellsands*

Having shown the existence of a foreshore drifting south-south-east from Formby point, past Hightown and Blundellsands, towards Seaforth, the cause of the erosion at Hightown and Blundellsands becomes clear. As already stated, the river Alt enters upon the beach at Hightown, but when uncontrolled (that is, previous to 1936) it flowed a considerable distance south-south-east along the foreshore before it turned seaward. The foreshore drift from Formby point to Seaforth causes the mouth of the Alt, where it enters the main channel of the Mersey, to be filled in constantly from the northern side, thus driving the river southward. In fact, the drift is so great that the river never succeeded in making an actual channel right across the beach to l.w.m., but, where it turned seawards, divided into a number of distributaries of very slight depth and ill-defined route. The whole of Formby bank and the course of the river along the foreshore from Hightown is covered at every tide, and it is then that the foreshore drifting occurs. Besides this drift which drives the mouth of the Alt southward, the action of blowing sand drives its course along the foreshore eastward, that is, landward. The dominant west wind blows sand eastward across Formby bank, and this is trapped by the west 10 feet of the width of the river Alt, for owing to the individual grains progressing in a series of hops,[1] it cannot cross the river. Most of this sand is washed out by the scour of the river current, yet some remains, and this causes the river to erode its landward bank, making it constantly move its course nearer and nearer to the foot of the dunes.

The presence of the river Alt prevents the wind from blowing sand inland to replace the wastage by the waves, and by this and the deepening action of the Alt, the beach is lowered. Since the date of the last Ordnance Survey revision, the beach has been lowered so much opposite the Serpentine and Burbo Bank Road North, that there is now no backshore and the sea is several feet deep at the foot of the slag at every tide. This low level of the beach enables large storm-waves to break near the water-line and to dissipate their energy there, instead of doing so considerably further out to sea. The removal of the Alt from the Blundellsands foreshore in March 1936, if the dams are not broken through by winter storms, removes the cause of the lowering. Since however the sand to build up the level again must come from Formby, its transportation is very difficult owing to the presence of the two dams, which stop all foreshore drifting except round their seaward extremities. Although the beach has been free of the Alt opposite Blundellsands for over a year and a half, the old river channel is still (September 1937) well defined and the process of natural raising of the sand to its old level has not begun.

[1] R. A. Bagnold, "The movement of desert sand," *Geogr. J.* 85 (1935) 342–369, especially pp. 349–353. It is well known that sand grains proceed by a series of hops and cannot cross a band of water wider than about 10 feet.

Whether it will do so is extremely problematical, and while the beach remains low there is constant danger of erosion.

*Causes of the erosion at Formby point*

The cause of the erosion at Freshfield and Formby is the lowering of the shore, which allows a greater number of tides to reach the foot of the dunes and also permits the waves to break further up the shore. The erosion takes place entirely during spring tides or during storms coinciding with full tide. No measures are being taken to combat the erosion.

A study of the percentage duration of wind in various directions at Southport during the last thirty-seven years fails to show that any change is occurring, so that this does not afford any explanation as to why accretion has been replaced by erosion at Formby. Since it has been concluded that foreshore drifting is occurring away from Formby in both directions, it follows that the supply of material must come from the wastage of the dunes at Formby, from the shore at Formby, or from below low-water mark. It is suggested therefore that until shortly before the erosion began (about 1906), the supply was from below l.w.m.; that, say about 1900, for some reason at present unknown, the rate of supply decreased, so that as the material of the foreshore was drifted away from Formby, it was not wholly replaced. This caused a lowering of the level of the beach and in consequence erosion followed.

There would naturally be a time-lag between the partial failure of the supply and the incidence of erosion. This is shown by the surveys, for the backshore had been narrowed, indicating the lowering of the beach, by 1906, but erosion is not shown until the survey of 1925. The year 1906 may not of course mark the most seaward extension of the dunes, but if erosion had already begun it was small in amount. No direct information has been obtainable as to the year in which accretion was converted into erosion. The continuance of erosion and a low shore indicates that the supply of fresh material is still deficient, and that the shortage for the foreshore drift is being made up by erosion of the dunes and the lowering of the shore. The process by which the supply of sand is brought from below l.w.m. being entirely unknown, no suggestion can be offered in explanation of its partial failure.

*Conclusion*

This portion of the Lancashire coast affords interesting studies of shoreline processes in sand free from shingle, where the tidal range is great and the size of waves, owing to the enclosed nature of the Irish Sea, is small. The discovery of the foreshore drifting away from the centre point in the two opposite directions, coupled with the inferred partial failure of the supply from below l.w.m., provides a single, complete explanation of the previously apparently unconnected tendencies of the various parts of the coast: the accretion and stability from Southport nearly to Freshfield, the erosion at Freshfield and Formby, the stability at the Rifle range, the southward migration of the river Alt, the erosion at Blundellsands, the stability from Blundellsands to the commencement of the docks.

The surveys used in making the map showing the migrations of the river Alt's mouth were: 1689, Greenville Collins; 1736, Fearson and Eyes; 1760, Mackenzie, Sen.; 1765, Bowen; 1766, Williamson; 1767, Fearson and Eyes;

1818, Greenwood; 1827, Thomas Evans; 1834, Denham; 1866, Mersey Docks and Harbour Board; 1888, Ordnance Survey; 1899, Mersey Docks and Harbour Board; 1907, Ordnance Survey; 1913, Mersey Docks and Harbour Board; 1918, ditto; 1925, Ordnance Survey; 1928–33, Mersey Docks and Harbour Board; 1934–36, Gresswell.

# FACTORS IN THE DEVELOPMENT OF THE COTSWOLD WOOLLEN INDUSTRY

R. P. BECKINSALE

THE West of England woollen manufacturing areas extend from North Oxfordshire southwards into Devonshire, but the broadcloth-making districts centred upon Stroud in Gloucestershire, Trowbridge in Wiltshire and Frome in Somerset, and the serge-making districts in Devonshire and Somerset have in various degrees all come under the influence of geographical and economic factors common to the whole region. Generally speaking, the major centres of the industry were grouped about the outcrops of the limestone hills. North of Bath, the limestone escarpment is known as the Cotswold Hills and these hills formed the nucleus of the broadcloth manufacturing areas of the West of England. Hence the following account of the clothing industry of this area is more or less typical of the development in the whole region. The chief manufacturing areas upon the Cotswolds were around Stroud in Gloucestershire and Witney in Oxfordshire and these districts will now be discussed separately.

*Gloucestershire*

*Early history of cloth-making and of the woollen trade.*—The history of the Cotswold woollen industry may be said to begin in Roman times when the large villa at Chedworth was probably a dyeing and fulling establishment based upon a good water supply and a local deposit of fuller's earth.[1] Cloth may have been made at Cirencester also but it is impossible to prove that the later cloth industry had a continuous history from these times. Many spindle-whorls have been excavated at Chedworth and in Romano-British encampments throughout the Cotswolds. A fine example of a Saxon weaver's hut was unearthed recently near to the River Windrush at Bourton-on-the-Water in north Gloucestershire. Hence the cloth-making industry in the Cotswolds is of considerable age.

With the coming of the Normans sheep-keeping flourished and with it an export trade in wool and fells. The fortunate existence of the famous local breed of Cotswold sheep, with a long weighty fleece of a special "mellow" character [2] meant that the vast open downlands on the limestones could be used most profitably for sheep-ranching.

[1] *Transactions of the Bristol and Gloucester Archaeological Society*, XXX, 1907, 13–17.
[2] 'Cotswold Flock Book' I and II, 1892 and 1893, i–xv.

As early as the twelfth century, Flemish traders came for wool and in the thirteenth, Beverstone parish alone had nearly 6000 sheep, and many of the settlements had "a common pasture called the Wold in which the lord can have 1000 sheep of his own." [1] Before 1315, seven of the numerous and powerful monastic houses in the neighbourhood were sending wool to Italy and Flanders. In the reign of Edward II, Gloucester Abbey sold its wool to a New Sarum citizen,[2] and some years later 30,000 sacks of Cotswold wool were granted annually from Gloucestershire for the king's household.[3] So important did the trade in wool become that Bristol was made a staple town (1353) and William Grevel of Chipping Campden (*ob.* 1401) could be called "flos mercatorum lanae totius Angliae." The best idea of the Cotswold wool trade in the fifteenth century may be obtained from the letters of the Cely family. These influential wool merchants dealt chiefly with two men of Northleach, a town whose central position in the North Cotswolds made it a great wool market. Very typical are the entries describing the buying of sixty sacks "of Cottys woll the weche ys in pyle at Norlache and John Caly hath gadered and bogwyt for me in Cottyswolde xxxvij sack." [4]

In the meantime the high profits to be derived from the sale of raw wool had probably discouraged the local manufacture of woollen cloths for other than domestic uses, yet, on the other hand, the association with the great cloth-making cities abroad would tend eventually to benefit the home manufacture. In the twelfth century Cirencester and Gloucester had merchant guilds.

*Growth of the woollen industry: the Vale phase.*—The increasing production of cloth locally may be judged by the increase in the number of fulling-mills, two of which had been built on the Upper Windrush by the Templars before 1200. In the reign of Edward I there was a fulling mill at Hawkesbury near Wotton-under-Edge, and some one hundred and fifty years later another is recorded near Stroud, where grants of mill streams begin to appear. It was but natural that foreign artisans should migrate to a region so long known to them for wool, and at Cirencester the cloth trade was encouraged by an influx of foreign merchants as early as 1315. A few years later, Thomas Blanket was employing foreigners at Bristol.

During this period the cloth-making industry was mainly concentrated around Bristol and less so around Gloucester and a few of the other larger settlements in the Severn Valley. Evidence of the growth of the industry upon or near the Cotswold escarpment has already been given, and in the fifteenth century Painswick had mills, probably for cleaning and dressing cloth. The Stroudwater area did not begin to assume its modern importance until after 1515 when Flemish and Huguenot artisans settled there. Then Bristol, being able easily to import dyewood (and later the cochineal insect from Spain) was famous for "Bristol Reds," but it is remarkable how rapidly foreign

[1] Accounts of this and of many other facts mentioned in the article are to be found in the *Trans. B.G.A.S.* Only the few more important references are cited.

[2] *Trans. B.G.A.S.*, XXXVIII, 1915, 34.

[3] 'Victoria County History of Gloucestershire,' II, 1907, 151–193, for this and many other facts.

[4] "The Cely Papers," *Campden Soc. Publications*, 3rd Series, I, 21. [1 Sack = about 365 lb.]

influence spread up the Severn Valley and how quickly the distribution of the industry changed. Fresh mills spring up along the escarpment slope, much of the manufacturing departs from the Vale towns and the power of the guilds declines. After 1629 there is no mention of the guild at Gloucester and here, as at Bristol, cloth-making becomes either insignificant or extinct.

*The Hill phase.*—The fifteenth and early sixteenth centuries mark three distinct changes in the Gloucestershire woollen industry. Firstly, the "domestic system" replaces the older guild system and the cloth-making industry is soon scattered throughout the Cotswolds and especially along the escarpment slope. Secondly, the Cotswolds cease to be famous for wool export and become equally famous for the export of woollen cloths. The local production of wool went on increasing and in Defoe's day 20,000 sheep were generally sold at one fair at Stow-on-the-Wold and the Cotswold flocks exceeded half a million. Yet the cloth industry grew so fast that the import of foreign wool soon dwarfed the local supply. Thirdly, with the continuous influx of foreigners, there is an ever-increasing specialization in the manufacture of fine broadcloths. A number of Stroud manufacturers when giving evidence in a State inquiry stated that "their forefathers . . . made only coarse cloths of a blood colour with black Irish lists. They themselves about thirty years since (that is about 1605) began to make finer cloths and dressed them far better. . . . They made of the same near 3000 every year." [1] Before this time little is heard of "finer cloths " and the bulk of the cloth produced must have been of a coarse nature. Indeed, for another century considerable quantities of these coarser cloths were produced. The manufacture of fine broadcloths demanded a shorter and finer wool than the bulk of that which was grown locally.

About 1470 Gloucestershire was producing one-eighth of the total English output of woollen cloths as shown by the aulnage returns, and its production was only slightly exceeded by that of Suffolk, Somerset, and Yorkshire, the three leading counties.[2] Within a few years, Bristol was exporting well over 5000 cloths annually and new fulling-mills were springing up in the hill towns, such as Cirencester, as well as along the escarpment slope. In 1677, when Parliament tried to confine cloth manufacturing to the towns, so famous were Gloucestershire "Whites and Reddes" that the Stroud area was one of the few exempted districts. The annual import of Spanish wool now exceeded 100 cwts.

The state of the industry in the early seventeenth century is well shown by statistics compiled by the writer from a catalogue of the able-bodied men of Gloucestershire.[3] The Vale towns, such as Gloucester, are declining rapidly and the industry has largely migrated to the swift streams of the western Cotswolds where "over-shot" mill-wheels gave greater power for the beating of finer cloths. The settlements upon the dip slope of the limestone hills, except Cirencester and Tetbury, are of little importance and,

[1] W. St. Clair Baddeley, 'A Cotteswold Manor,' Painswick, 1929, 183, for cause of inquiry.

[2] H. Heaton, 'The Yorkshire woollen and worsted industries,' 1920, 85.

[3] J. Smith, 'The return of men and armour for Gloucestershire in 1608.' Republished in 1902.

although their trade increases in the next century, most of them owed more to wool than to woollen cloth. The compilation shows the great importance of the Stroudwater, Dursley, and Wotton areas, especially in the finishing processes. 85 per cent. of all the able-bodied men engaged in the Gloucestershire woollen industry were to be found here, including nearly 90 per cent. of all the fullers. Altogether 2560 able-bodied males were employed in the various branches of the industry. Of the 1776 male weavers named, 280 were classed as "brodewevers," and these also lived mainly near the escarpment slope where foreign influence had been most felt.

That the output of coarse cloths continued to be important is proved by a letter of Charles I to Prince Rupert in 1643. Rupert was informed that at Cirencester, Stroud, Minchinhampton, Tetbury, Dursley, Wotton, and Sodbury great quantities of coarse canvas and coarse cloths were available for clothing their troops, for which purpose he was to buy the same and collect it at Cirencester.[1]

*The period of prosperity.*—Generally speaking, 1690 to 1760 seems the period of greatest prosperity among Cotswold cloth-makers, to which conclusion the fine houses and monuments erected about this time testify. Over 50,000 cloths were made annually and "no other manufacture deserves to be mentioned in comparison of it."[2] About 1725, Cirencester, Painswick, Wotton, Marshfield, Minchinhampton and Fairford are all mentioned as making a fine Medley or mixed cloth, usually worn in England by the better class of people and also exported in large quantities to Europe. The widely separated towns "are interspersed with a very great number of villages, hamlets, and scattered houses, in which, generally speaking, the spinning of all this manufacture is performed by the poor people. The Master Clothiers, who generally live in the greater towns, sending out the wool weekly to their houses, . . . and at the same time bringing back the yarn that they have spun and finished . . ."[3] Apparently the manufacture of white cloth had been planted in the Stroudwater area owing to the water being excellent for dyeing scarlets and "all colours that are dyed in Grain." The local wool supply was supplemented by North Country wool, by Kentish wool from London, and by Irish and Spanish wool from Bristol. Cirencester was the great market for English wool supplies and in addition supplied yarn to places as far distant as Frome, Warminster, and Taunton. About this time Stroud alone needed nearly three million fleeces annually, and some broadcloths rose in price to forty-five shillings a yard.

*The coming of the factory system.*—A strike of the weavers in the Stroudwater district in 1758 marks the stage when the "factory system" begins to depress the "domestic industry." This factory system had been increasing slowly since the attempts at centralization made by Thomas Blanket of Bristol in the fourteenth century. After the Dissolution, the ruined abbeys formed good sites for such attempts, and at Cirencester "a right goodly clothing mill" was set up in the Abbey ruins. Malmesbury Abbey was filled with looms and

[1] The letter still hangs on the wall of one of the mills. It is quoted in Morris and Wood. 'The Golden Fleece,' 1922, 110–111.

[2] Cox, 'Magna Britannia,' II, 1720, 809.

[3] Defoe, 'A tour through the Island of Great Britain,' II, 36–39.

the town soon produced three thousand cloths annually. Only the strong opposition of Parliament deterred the rich Cotswold clothiers from centralizing their concerns. Equally powerful was the opposition of local workers to the introduction of labour-saving machinery. As early as 1485 one owner of a fulling-mill near Stroud had been mobbed, yet in spite of continuous violent opposition the introduction of elaborate machinery and of steam-power took place from 1760 to 1840. In 1807 the chief manufactures were woollen broadcloths, chiefly superfine, made of Spanish wool, "and fine narrow goods in the stripe and fancy way, to a very great extent." At Cirencester, thin stuffs called Chinas were made from worsted yarn, a little carpet-weaving was done and some woollen cloths were made for the Army and the East Indian Company, which cloths were sent undyed to London. The trade generally was said to have decreased considerably with the introduction of machinery.[1] Cobbett noted that the Stroudwater turned "the wheels of a great many mills and sets of machinery for the making of woollen-cloth. There are steam-engines as well as water-powers." He stated that the empty cloth-drying racks testified to the depression of the trade.[2]

These contemporary writers tend to give a misleading idea of a general depression in the industry. It is true that the scattered villages suffered greatly when the woollen industry migrated to a few towns, but those towns where concentration consequently obtained continued to flourish for many decades. Some towns had long since attempted to avoid the threatened depression by specialization; for example, Tetbury, with no water-power, in wool-combing and spinning; Cirencester, where the hard waters of the Churn were unsuitable for dyeing, in thin yarn for the hosiery and worsted centres. Yet the continued introduction of machinery intensified the concentration and, except around Stroud, merely postponed an inevitable extinction as the Yorkshire mills were now capturing most of the market. The flourishing trade in a few of the towns contrasts vividly with the depression in most of the rural districts. In 1816 and 1817, one Stroudwater firm bought Spanish wool worth nearly £80,000 and obtained contracts from the East Indian Company which rose in amount up to 10,000 pieces of cloth, each cloth being 36 yards long by nearly 5 feet wide. A few years later, one payment made to the firm by the Company came to nearly £25,000.[3]

In Painswick parish, where thirty cloth-mills had been in work as well as hand-looms in many cottages, the clothing industry prospered until 1830 when Stroud introduced power looms and definitely began to monopolize the industry. Elsewhere the opposition of the workers resulted in serious strikes and prevented or discouraged the establishment of machinery and power looms in their localities. In 1836 Cirencester lost its carpet weaving when many of its workers went to Kidderminster and there was a marked emigration of the rural population from several of the parishes around Stroud. Yet from 1851 to 1861 the workers employed in the Gloucestershire woollen industry increased from 4459 to 7050 and even then "doeskins, venetians and kerseymeres were still handwoven in scores of cottages" and the click

[1] Rudge, 'Agricultural survey of Gloucestershire,' 1807, 341 *et seq.*

[2] Cobbett, 'Rural rides (1821–1832),' II, 141.

[3] A. T. Playne, 'History of Minchinhampton and Avening,' 1915, 151.

of the cottage loom was a familiar sound.[1] In the next decade the number of woollen workers decreased by about 1000 and by 1901 the numbers had decreased to 3321. Up to about 1875, when a new vogue for ribbed stuffs made Yorkshire supreme, the Gloucestershire mills made slight but diminishing efforts to follow the fashions.[2] After that date the annual output of cloth began to decline, although about fifty years later the Gloucestershire production became as great as ever it was.

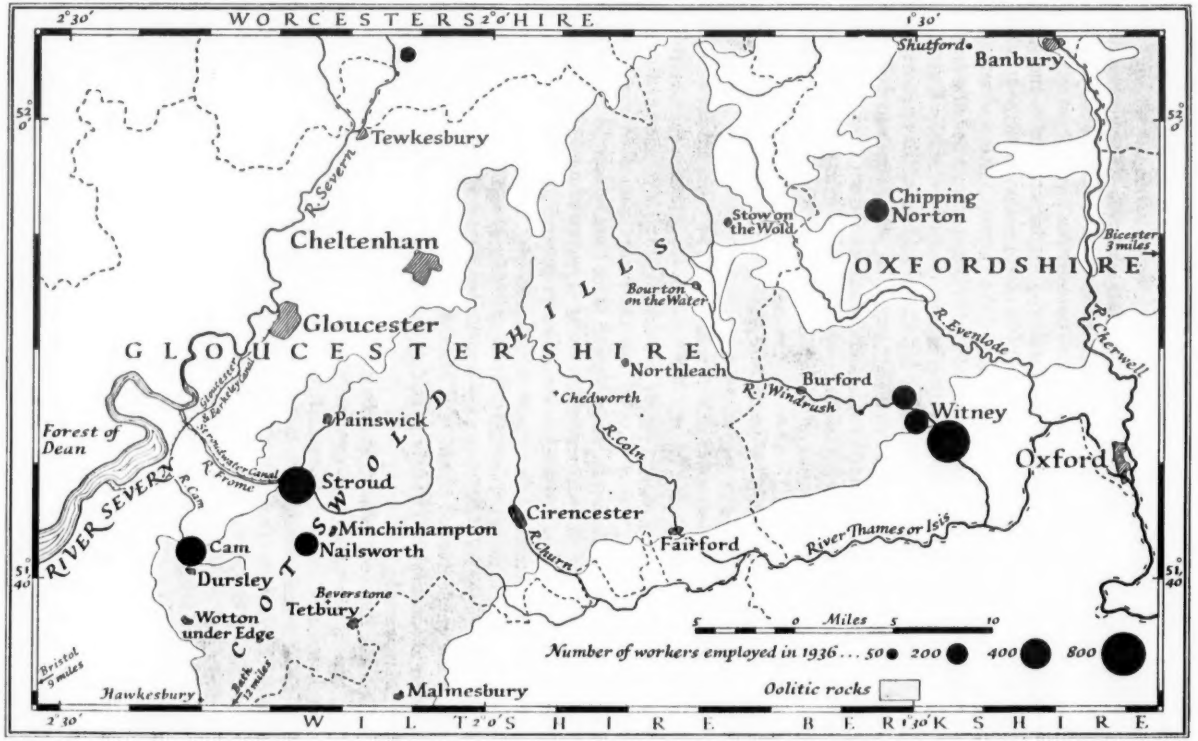
*Present state of the woollen industry in Gloucestershire.*—The local manufacturers specialized in superfine broadcloths which needed much heavy fulling and felting. Blue for the Navy, red for the Army and hunting, green for billiard tables, cloth for pianos, liveries and dress-suitings were the chief products. The household troops of many European courts were clothed in Cotswold broadcloth as also were those of the East Indian Company. To-day the area still specializes in smooth, highly-finished cloths, the chief products being cloths for uniforms, white and grey flannels, dress-suitings, hunting-pink and covert coats. In some cloths, such as billiard-table cloths and the best tennis-ball coverings, this neighbourhood has practically a monopoly. In 1936 there were seven factories here engaged in the making of cloths. Five of these are upon the River Frome, another upon a tributary, and the remaining mill is upon the River Cam near Dursley. One mill is reputed to date back over five hundred years and the others are of considerable age. To-day they are well equipped and usually undertake all the processes of manufacturing within the one factory. The spindles in use number 31,000 and the looms nearly 560. Those establishments upon the Frome still derive some power from its waters and in addition most mills use steam, the coal coming almost entirely from the Forest of Dean, and one or two obtain an electrical supply from the grid system.

Of the raw materials needed for the manufacture of cloth: the teasles come from Normandy and Somerset; the wool mainly from Australia and South Africa; the small quantities of fuller's earth still used from Bath. Only four mills now deal exclusively with pure woollen goods and produce, in addition to the specialized products mentioned above, fancy woollens and flannels. The others make worsteds also, including the best quality worsted cloths for suitings. The factories are well served by rail and road and a little canal traffic, chiefly coal, is still done on the Stroudwater Canal. The market is world-wide as the frequent mention in the Order Books of for example Persia, Iceland, Poland, and the West Indies will testify. The British Army remains a good customer, and this is probably the only area in Britain where cloths are still dyed with cochineal.

To-day the cloth-making industry in the Stroudwater area employs 1400 people, of which nearly two-thirds are women. In addition many mills are to be found which make small quantities of carpets, rugs, blankets, mattresses, flock, shoddy, hosiery, and elastic manufactures. This list, which could be much extended, varies periodically but is sufficient to show the variety of goods made in the neighbourhood. Yet in 1931 the textile workers in

[1] *Trans. B.G.A.S.*, XXXVI, 1913, 329.

[2] For example, from 1851 to 1891 the number of persons employed in the Gloucestershire worsted industry rose from 4 to 67.


2°30'
WORCESTERSHIRE
2°0'
1°30'
52°0'
51°40'
Shutford
Banbury
Tewkesbury
R. Severn
Cheltenham
Stow on the Wold
Chipping Norton
Bicester 3 miles
OXFORDSHIRE
COTSWOLD HILLS
Bourton on the Water
R. Evenlode
R. Cherwell
Gloucester
GLOUCESTERSHIRE
Northleach
Burford
Chedworth
R. Windrush
Witney
Painswick
Forest of Dean
Gloucester & Berkeley Canal
Thames & Severn Canal
R. Frome
Stroud
R. Colne
Oxford
RIVER SEVERN
R. Cam
Cirencester
Minchinhampton
Nailsworth
Cam
Dursley
R. Churn
Fairford
River Thames or Isis
Beverstone
Tetbury
Wotton under Edge
5 0 Miles 5 10
Number of workers employed in 1936 ... 50 200 400 800
Bristol 9 miles
Bath 12 miles
Hawkesbury
Malmesbury
Oolitic rocks
WILTSHIRE
BERKSHIRE

Gloucestershire (excluding Bristol and Gloucester) only numbered 2589, and most of these were in the Stroud area. Of the 920 ordinary weavers in the county no less than 214 were men.

*Geographical factors affecting the woollen-cloth industry.*—The geographical factors favouring the rise and continuance of the woollen industry in the Stroudwater area may now be reviewed. They seem to be:

Firstly, a local wool supply, which was of great importance in the early stages of the industry when chiefly coarse cloths were made. With the specialization in superfine broadcloths the fleece of the Cotswold sheep was largely superseded by that of the merino breed and of the shorter-woolled sheep in Hereford, Wales, and the Midlands. Probably the fleece of the Cotswold sheep grew coarser when the animals' bulk increased owing to crossing, but in the seventeenth century the excellent supply of local wool was still considered a great advantage, and in 1800 the shorter wool from local fleeces was woven into army cloth. Less than thirty years ago one firm produced cloths made entirely from Cotswold wool, but to-day only one or two flocks of Cotswold sheep survive. In addition, the early woollen trade had greatly stimulated the cloth-making industry by creating an accumulation of capital which could be invested in manufacturing.[1]

Secondly, abundant supplies of soft water could be obtained for scouring and fulling. Between Painswick and Wotton is the only area in the Cotswolds where the outcrop of the sandy beds is thick and extensive enough to yield a large supply of soft water. The bulk of the waters carried to the Frome and Cam rivers comes from springs issuing from the Cotteswold Sands and analyses show that the permanent hardness of these waters is remarkably low and in some cases is insignificant. Springs rising from the oolitic limestones and other strata locally usually have a permanent hardness three or more times as great.[2] Furthermore, the temporary hardness of the water from the sands is so easily removed that a spongy, limestone deposit forms naturally where the small streams tumble and are shaken. It seems that the low permanent hardness was the factor which gained the Stroudwater its reputation for use in washing and dyeing.

Thirdly, the steep escarpment slope with its heavy rainfall (reaching over 34 inches in an average year) gave rise to many streams which were faster than elsewhere in Gloucestershire and were constant in volume. The small Painswick Stream for instance had a mill every few hundred yards along its course. Later it was found that the deep valleys, often dissected down as far as the Lias Clays, were well suited for the making of lake reservoirs needed by the bigger mills. The effect of the abundance of soft water and of water power is well seen in the distribution of woollen workers in Gloucestershire in 1608.

Fourthly, the position near to Bristol and the Severn was important early as leading to an influx of foreign artisans and later as giving both ease of

[1] Compare R. H. Kinvig, "The historical geography of the West Country woollen industry," *Geographical Teacher*, VIII, 1915–1916, 243–254, 290–306. Here full justice is scarcely given to the influence and early importance of the local wool supply.

[2] L. Richardson, "Wells and springs of Gloucestershire," *Mem. Geol. Surv.*, 1930, for analyses.

import of wool and export of cloth. The Severn itself was much used for the carriage of raw materials until the coming of the Gloucester Ship Canal and the Stroudwater Canal system.

Fifthly, various less important advantages assisted the industry locally, such as a good local supply of fuller's earth which in some cases was actually upon the premises. Teasles (and woad for preparation in the dyeing of cloths black) grew well in the neighbouring Vale parishes. By 1807 the area under teasles had decreased to 100 acres, and to-day only a few acres are grown in most years.

It was these factors which fixed the industry in its present position and gave the area much of its reputation. To-day proximity to the Forest of Dean coalfield is a further asset in assisting the chief permanent factors, water-supply and business traditions, to carry on successfully the cloth-making trade. Naturally the Stroud and Dursley districts, where the capital accumulated on the Wold and in the Vale encountered the greatest advantages locally for cloth making, remained the chief woollen manufacturing areas in the Cotswolds.

*Oxfordshire*

*Early history*.—In Oxfordshire the woollen industry was always much less important than in Gloucestershire. The Cotswold Hills form only the western strip of the county and are continued north-eastwards, beyond the Evenlode River, as the North-Oxfordshire Hills and Edgehill. The outcrops of limestone are small, most of the slopes are dip-slopes and there is a relative absence of swift streams suitable for driving mill-wheels. In contrast to the Severn Valley, Oxfordshire was far inland but happened to be athwart the main routes from Wales and the Upper Severn Valley to London, and the coaching trade which consequently developed had a marked stimulating effect upon the woollen manufacturing industry in the local coaching centres. The only district which early acquired a notable reputation was around Witney where there was a fulling-mill and a woollen trade before the Norman Conquest. Henry I expended twenty pounds upon his wardrobe during a visit to the town [1] and in 1385, when the blanket industry began, there were several fulling-mills here and many hundred fleeces were imported from the hills to the north. Broadcloth-weaving became the chief industry and blanket-cloth the main product.

In the fifteenth century weaving was carried on in all the larger settlements of Oxfordshire, such as Chipping Norton, Burford, Bicester, Banbury, and Oxford. At Oxford the cloth-making industry, which had practically died out in the fourteenth century, enjoyed a short-lived revival about 1550 when an attempt was made to turn Osney Abbey into a factory for two thousand woollen workers and a fulling-mill was erected.[2] Except at Witney, the domestic industry remained of little importance up to the end of the seventeenth century, after which a marked localization of the industry caused Witney, Banbury, and Chipping Norton to be outstanding. The development of the clothing industry at each of these centres will be discussed separately.

*The plush industry at Banbury*.—In the seventeenth century Banbury

[1] 'V.C.H. of Oxfordshire,' II, 242.
[2] *Ibid*., 227.

became a great coaching centre, and in 1701 the foundation of web and horse-clothing factories reflects a local demand. Soon afterwards the manufacture of worsted plush, a kind of coarse velvet, was centred here and spread into all the neighbouring villages. By 1850 the plush and girth trade was employing over 125 men in Banbury and probably three times as many in the vicinity. Three firms were making plushes and other very heavy fabrics of worsted and cotton. 430 looms were in use and there was a large trade with Southern Europe. Another factory spun worsted and mohair and three others made webbings, horse-cloths, girths, etc., and supplied them to such towns as Bristol, Glasgow, and Birmingham.[1] The industry however was based on economic conditions rather than on geographical advantages, and the competition mainly of Yorkshire mills caused the last plush mill in Banbury to close down about thirty years ago. To-day the manufacture of plush in Oxfordshire survives only at Shutford, a small village some 5 miles from Banbury situated upon a high watershed and several hundred yards from any stream. The present "factory" was founded over a century ago for the finishing and disposing of hand-made plush woven in the nearby cottages. In 1900 power-looms were introduced and the cottage industry faded away. To-day half a dozen power-looms are driven by a gas engine and a few hand-looms are worked in the traditional way.

Coal is obtained chiefly from Wales and Coventry; wool, worsted, silk, and mohair from Yorkshire and cotton from Manchester; rain water collected from roofs is used for dyeing and scouring, but at various stages of the finishing processes the cloths are carried to the nearest stream for washing.

The speciality is still the finest hand-woven plush for liveries such as in the last century was supplied to most of the European Courts. Bright scarlet is still made for the Royal Household, Windsor Green for the Royal Foresters, plush upholstery for the Houses of Parliament, and livery cloths for a few of the ancient families of England.

Other qualities of hand-made plush are used in Yorkshire for raising a nap on cloth, considerable amounts go to Ireland for use in the finishing of linen and to Lancashire for use as cotton cleaners and drag cloths. Another speciality is power-made plush for printing machines and for photographic and other industrial uses. Of the direct export abroad it is noticeable that the United States, South America (especially the Argentine), Holland and Scandinavia remain fairly regular customers. Thus to-day specialization and a reputation acquired during the previous century, maintain the industry in a position which lacks any obvious geographical advantage.

*The tweed industry at Chipping Norton.*—Chipping Norton is situated upon the main Worcester to Oxford road amid the limestone hills of North Oxfordshire. Its woollen manufacturing first rose to importance after the foundation of the present mill in 1746. During the first eighty years of its existence the influence of the coaching trade is seen in the large output of webs and horse-clothing. Kerseys also were made.[2] Then the specialization changed to serges and tweeds for which a European reputation was gained. To-day the factory employs over two hundred persons and specializes in fine tweeds,

[1] 'V.C.H. of Oxfordshire,' II, especially 247–252.

[2] Kersey: a coarse, narrow cloth woven from long wool and usually ribbed.

flannel cloths, sports clothes, and suitings. The mill is situated upon a small tributary of the River Evenlode and immediately adjoins the railway station, whither the coal from Warwickshire and the fine wool from Australia come. The water supply, which is derived from springs and collected in reservoirs, is hard and is specially treated before being used for scouring and milling. The finished products leave by rail for the home market as well as direct to North America and the Continent. None of the required raw materials can be obtained locally and the flourishing condition of the industry rests largely upon a long-established reputation.

*The blanket trade at Witney.*—Before 1700 Witney had acquired a remarkable reputation for blankets. A contemporary describes how "the Blanketing trade . . . is advanced to that height that no place comes near it; this place has engrossed the whole trade of the Nation for this Commodity." [1] There were at least three score blanketeers and 150 looms in the town. The wool, which came from all parts of the kingdom, was separated into various lengths. The long fell wool was sent to the Wells area for making worsted stockings, the other wools were made into blankets of various widths. The second great product of Witney was duffields, which were made in pieces about 30 yards long by two yards wide and were dyed red or blue, the colours most pleasing to the Indians of Virginia and New England, with whom the merchants trucked for beaver furs, etc.[2] In addition wrappers for blanket wrapping, tilt-cloths for bargemen and cloths used by the coaching traffic were made. The finished products were sent weekly in waggons to London and the return loads consisted mainly of fell-wool. The very white nature of the blankets was thought to be due to the "abstersive nitrous" qualities of the River Windrush or else to the peculiar way of loose spinning.

Before the middle of the eighteenth century a Company of Blanket Weavers had been formed by charter and given "the sole right of manufacturing blankets . . . in Witney, or within 20 miles of the same." Spinners in all the neighbouring villages made yarn for the Witney manufacturers. Arthur Young (1768) writes that the very famous woollen manufactory "consists of what they call kersey pieces, coarse bearskins, and blankets. The two first they make for the North American market; vast quantities being sent up the river St. Lawrence, and likewise to New York, Boston, etc. Their finest blankets . . . are exported to Spain and Portugal; but all are sent to London first in broad-wheel waggons of which four or five go every week. The finest wools they work, come from Herefordshire and Worcestershire, the coarsest from Lincolnshire . . . are used for making coarse bear-skins. They weave according to the seasons; in winter kerseys and bearskins, ready for shipping in summer up the St. Lawrence; and in summer blankets for home consumption and Spain and Portugal." [3] At this time there were 400 weavers using 7000 packs of wool annually, and the number employed in the woollen industry probably exceeded 2000. Forty years later the same traveller describes how the introduction of labour-saving machinery had warded off

[1] R. Plot, 'Natural History of Oxfordshire,' 1677, 278 *et seq.*

[2] Duffield or duffle: from Duffel near Antwerp, a coarse woollen cloth having a thick nap or frieze.

[3] A. Young, 'Six weeks' tour through the southern Counties . . .,' 1768, 99.

a threatened depression. The flourishing condition of the industry was partly ascribed to the superabundance of labour which kept wages down and compensated for the distance from coal.[1] From 1823 to 1828 the Order Book of one firm shows an annual average volume of business of 20,000 pairs of blankets, nearly 400 pieces of blanketing, usually over 40 yards long, and a few other cloths. Over half this output went abroad, chiefly to North America. The two British Government contracts taken by the firm in these years amounted to over 80,000 blankets.[2]

Cobbett (1826) describes how the introduction of machinery at Witney had given it a monopoly of the blanket-making to the great detriment of nearby villages.[3]

It is apparent that at Witney concentration into factories preceded the introduction of power-looms as in 1836 there were no power-looms in Oxfordshire and only four for woollens, recently introduced, in Gloucestershire. Even after the introduction of power-looms at Witney in about 1850 hand-looms survived in the mills for many years.

*Present condition of the blanket industry.*—From 1700 to the coming of steam power and modern machinery the number of hands employed was about 3000, which then almost immediately dropped to some 800 operatives with 250 looms in use. To-day there are 1130 workers and the number of looms has been almost doubled. Over half of the 14,000 spindles in Oxfordshire are in the Witney area. The annual output has risen to an average of 700,000 pairs of blankets which is one-fifth to one-quarter of the total production of Great Britain. The workers consist almost equally of men and women but, in contrast to conditions in the Stroudwater area, nearly all of the 400 weavers are women.

There are seven mills, five of which are upon the Windrush; the sixth is upon an abandoned arm of that river and obtains a good water supply from wells; the seventh has river water pumped to it. The last two mills mentioned are the newest and the nearest to the railway station. There are four firms of blanket manufacturers and three of these have one factory in the town itself for handling, blending, carding, spinning, and weaving, and another more isolated mill farther up the Windrush for washing, milling, and other finishing processes. The headquarters of the firms are always in Witney itself.

To-day practically the only product is fine-quality blankets, white or coloured. The major type of power used in the mills varies from turbo-electric to steam generated by crude oil. Much of the coal comes from South Wales and Warwickshire, but all the mills upon the Windrush still use some water power. The teasles needed come from the south of France and the wool from all over the world, including a local supply. Only two firms buy yarn from Yorkshire. Most of the blankets produced are sold to British firms, although South Africa is a good customer and smaller quantities go direct to North America, Europe, and the Far East. The chief means of dispatch from Witney is by rail.

[1] A. Young, 'General view of the agriculture of Oxfordshire,' 1809.

[2] Plummer, 'The Witney blanket industry,' 1934, 100. Deals in detail with the account book of the Witney Company of Blanket Weavers.

[3] Cobbett, 'Rural rides (1821–1832),' II, 177.

To-day about 2 per cent. of the total workers in woollen textiles in Great Britain are to be found around the borders of the Cotswold Hills in Gloucestershire and Oxfordshire.

*Geographical factors affecting the blanket manufacturing.*—Witney continued to prosper when most of the other towns on the dip-slope lost their industries mainly because it alone possessed the following advantages:

Firstly, at Witney the Windrush quickens its rate of flow where it crosses the cuesta of the eastern edge of the Cotswolds. Here was water power and also sites suitable for the erection of fulling-mills along the river.

Secondly, the water supply, although not exceptionally nitrous, is suitable for washing and dyeing. The quality of the water is probably only relative and may be explained as follows: To the north, the Evenlode, which rises upon and flows over large areas of clays, was comparatively sluggish and muddy. To the south, the Coln and Churn rivers flow mainly over oolitic strata and consequently their waters, although swifter than those of the Windrush, were harder and unsuitable for scouring and dyeing. The Windrush offered power and relatively clean soft water together.

Thirdly, the Cotswolds and the hills to the north supplied wools suitable for the making of blankets.

Fourthly, an isolated position far from coal, machinery, oils, and dyewoods, etc., was partly mitigated after 1750 when the main London to Gloucester road first passed through Witney. Witney was the only settlement in the neighbourhood where a main road passed through a woollen manufacturing centre with a good water supply. Like the other cloth-making centres of Oxfordshire it derived much benefit from a trade in waggon-tilts and horse-cloths. To-day the railway has solved the transport problem.

Fifthly, the supply of skilled labour was abundant and, as at Chipping Norton, there was no other competition for it.

Sixthly, the woollen industry here was aided by several important miscellaneous advantages such as the close concentration of the industry, a clean atmosphere for drying and, above all, the fortunate specialization in a product not affected by changes of fashions. This specialization is not easy to explain. Blankets needed less heavy milling than broadcloths, so it was advantageous for Witney to make them. An inland position meant that Witney was less influenced by the influx of foreign artisans than was Stroud, and the latter captured the local and foreign markets for the more valuable broadcloths and neglected blanket-making. Witney was more or less forced to deal largely with blanket-cloths and, when duffields and horse-cloths were no longer required, was still to be found specializing in a product which was increasingly in demand at home for bed-clothes.

To-day the water supply, labour supply, and rural situation are advantages, but it is the reputation and long-established trade connections which ensure the prosperity of the blanket industry at Witney.

*The influence of the woollen industry*

Besides giving the only large source of employment in several of the larger towns the woollen industry has left its stamp upon the Cotswolds in many ways. Most of the larger settlements have a hand-loom weaving establishment

where, with the aid of vegetable dyes, small quantities of cloths and rugs are produced for sale to visitors.

The place-names, street-names, and other names show close connection with sheep and woollen products to which may also be traced the origin of most of the surviving markets.

Throughout the Cotswolds the characteristic local style of domestic architecture was often modified to suit the needs of dealers and workers in wool. The wide double doors in the upper storeys of buildings allowed the woolpack to be lifted into the loom-room and the wide archway facilitated the entrance of pack-horses laden with wool. Many cottages have an exceptionally big room in which the loom was formerly worked.

The market towns with their halls and sun-dials, splendid churches and buildings, alms-houses and grammar schools owe their beauty to the wealth from the woollen trade, which was partly spent upon fashioning the excellent local freestone.

Most important of all is the multiplicity of minor industries which took advantage of the cheap, empty cloth-mills. 'Once a mill always a mill' seems to be the rule. In the Cotswolds the mills connected in some way with the woollen industry had numbered at least 150 and the empty factories attracted a variety of trades. A century ago many towns in northern Gloucestershire became famous for stocking making, and Tewkesbury alone had 800 frames at work employing 1500 persons. This industry has in its turn left the district. In Painswick parish there were twelve cloth mills upon the Painswick stream. Four of these became flour mills, four became pin or hairpin mills, one a timber mill, one a saw mill, and another a dyewood manufacturing factory.[1] Other old cloth-mills in the Stroud and Wotton areas are factories for pianos, sackings, patent fasteners, and celluloid products. Others are laundries and workshops. At Dursley the Lister firm, famous for dairy machinery, has its headquarters in a very old cloth mill and its workshops cover the sites of three others. Gloucestershire has long been noted for walking-sticks and umbrella handles, and when factory sites in Gloucester became very valuable, most of the industry migrated to the vicinity of Stroud and Wotton, where empty cloth mills were available as well as water power and local beech. In 1920 there were six large walking-stick factories employing some 600 hands, and to-day the wood workers of all kinds in this area nearly equal the woollen workers in number.

Hence it happens that the woollen industry in the Cotswolds has left to the region a kind of industrial legacy as well as historical and architectural attractions which give rise to a valuable tourist industry.

[1] Sir F. A. Hyett, 'History of Painswick,' 1928, 105–113.

# SOIL EROSION IN SOUTH-EASTERN UNITED STATES

F. GRAVE MORRIS

WILLIAM BYRD, the Virginian, who helped to run the dividing line between his native state and North Carolina in 1728, gives a vivid description of the River Roanoke at the point where it crosses the state boundary on its way to the sea. "In that place," he writes, "the river is 49 poles wide, and rolls down a crystal stream of very sweet water, insomuch that when there comes to be a great monarch in this part of the world he will cause all the water for his own table to be brought from Roanoke, as the great kings of Persia did theirs from the Nile and Choaspis because the waters of those rivers were light, and not apt to corrupt." [1] Twenty-four years later, in 1752, Bishop Spangenburg, canny and observant German, who was prospecting for the intended settlement of Moravians in North Carolina, entered in his diary concerning some of the upper streams of the Catawba River, "They are crystal clear, so that one can see the stones on the bottom even where the water is deep." Of the Yadkin he wrote, "The water is clear and delicious." [2] In such terms two observant men describe the rivers of the Piedmont of Virginia and North Carolina in the eighteenth century, before the white man had cleared the forests that then clothed the surface of the land. None could so write of them to-day, unless it were of the tiny head-streams that rise in the Blue Ridge or the Great Smoky Mountains, for, from the moment they enter into settled and cultivated land, they begin to assume a dirty, reddish-brown colour which increases every mile of their course towards the sea until, laden with the precious soil which thus discolours their waters, they deposit their burden upon the ocean floor. Not one stream in all the south-east flows "crystal clear" nor would any king seek to drink their waters.

This vivid contrast is illustrative of the severity of the soil erosion which is taking place in this region. England may have suffered in earlier times in this respect, when methods of cultivation were different from those which obtain to-day (although this is a question hard and perhaps impossible to

[1] Wm. Byrd's 'Histories of the Dividing Line betwixt Virginia and North Carolina.' Ed. by W. K. Boyd. Raleigh, 1929. Publications of the North Carolina Historical Commission, p. 156.

[2] 'Records of the Moravians in North Carolina.' Ed. by Adelaide L. Fries. Raleigh, 1922. Publications of the North Carolina Historical Commission, pp. 50 and 56.

answer), but under our existing agricultural systems we certainly suffer very little.

*Causes of soil erosion*

The south-eastern United States lie in a humid climate and experience a heavy rainfall, and soil erosion there is due to the action of running water. Conditions there are very different from those obtaining farther west, in the so-called "Dust Bowl" area, where soil erosion is primarily due to the action of wind. This paper is concerned only with the former type. Erosion due to running water takes two main forms: sheet erosion or the removal of the top soil from extensive areas; and gullying, where the action of the water is confined to definite channels. The latter is often more spectacular though the actual damage caused by it is less widespread than that caused by sheet erosion.

Erosion by running water is governed by a number of factors, amongst which five main ones may be distinguished.

*The presence or absence of a vegetative cover.*—So long as there is some form of continuous vegetative cover, whether of forest or of grass, the soil is held in place by the thick mat of roots and moreover in forested land the force of the rain is broken by the trees themselves. Some erosion does probably take place, particularly on slopes, but removal under such conditions is not more rapid than the formation of fresh soil. As soon however as the natural vegetative cover is removed, the soil is open to the action of running water and the intensity and character of the erosion depends on the other four factors. In the course of time a very large part of the land in the south-east has been cleared of its natural vegetation and therefore has suffered erosion in some degree. Though much land has of course reverted to woodland, the damage has already been done.

*The character of the agriculture.*—Where the land is cleared for agriculture the rate of erosion depends in part upon the character of that agriculture. In the south-eastern states cotton has for long been the chief cash crop, while corn has been the chief cereal. Both crops are planted at comparatively wide intervals apart, leaving between the rows a foot or more of soil open to erosion. Until the plants have attained considerable size this intervening strip is cultivated continuously in order to keep it clear of weeds. As a result the soil is kept in a pulverized condition which renders its erosion far easier. From the harvest in August and September to planting time in the Spring the fields remain fallow, cover crops and catch crops being generally unknown. Throughout the winter the fields are exposed in their entirety to the full force of the rain.

Yet erosion can take place even when the land is in pasture, if it is overgrazed, as is frequently the case.

*The intensity of the rainfall.*—The statement that the average rainfall of the south-eastern states is between 40 and 60 inches a year conveys but little of the reality. It is not the total amount but the intensity which is of importance in relation to erosion. In the records of twenty-six storms with excessive precipitation at Atlanta, Ga., during the years 1905 to 1928, over half an inch of rain fell in ten minutes on six occasions, while rainfall of more

than 1 inch in half an hour was recorded on nine occasions. On all but two of these occasions at least an inch fell within the hour, and in one case 3·19 inches fell in fifty minutes.[1] During such storms it is not uncommon to see the hillsides covered in a network of small streams, rapidly carrying away the soil and digging for themselves channels in the surface.

*The degree of slope.*—It is evident of course that the rate of erosion must depend in part on the slope of the land. There are undoubtedly many hillsides which have been cleared for cultivation and which had far better have been left with their natural cover of forest. Many hillsides are cultivated which are so steep as to preclude the use of a plough, hand labour alone being possible. Such slopes can be used perhaps for five or six years, after which, erosion having removed all the top soil, another patch is cleared and ruined in the same way.

*The character of the soil and the soil profile.*[2]—The character of the soil profile would seem to be important in certain cases in the headward development of gullies. The soils of the Piedmont, derived from igneous or metamorphic rocks, have a profile showing a thin upper or A horizon, usually sandy in character. The thickness of this varies owing to the amount of erosion which has occurred, but in a complete profile it might be as much as a foot. The B horizon generally consists of a compact clay from 3 to 8 feet in thickness. The C horizon consists of disintegrated, friable rock-material varying in thickness from a few feet to a hundred or more. The soils of the coastal plain are different in character, being derived from sands and clays. Horizon A is generally a sand or sandy loam and horizon B a sandy clay. It seems to be of some importance that in certain cases an indurated layer occurs at the base of the B horizon, which has the effect of throwing out water. The processes involved will however be discussed more fully in the consideration of the formation of gullies.

*Sheet erosion*

The clearing of the forest or, as in the Black Belt of Alabama, the breaking up of the sod and the use of the land for agriculture has led to the removal of a varying thickness of soil over very large areas. No definite channels are formed by the running water, but the pulverized soil is removed during heavy rains and washed into the rivers.

The extent to which sheet erosion has proceeded may be gauged by the fact that in many exposures of the soil profile little or none of the A horizon appears. Moreover in the mapping of the Piedmont soils large areas are shown as clay loam, which is really derived, in many cases, from the B horizon. Theoretically the A horizon and therefore the surface soil would be sandy, but this has been removed over wide areas. In the actual mapping by the Bureau of Soils, the texture of the present surface is used as the criterion for the division into soil types and so, where the present surface

[1] For the intensity of rainfall see the various sections relating to this area in the 'Climatic summary of the United States.' U.S. Department of Agriculture, Weather Bureau.

[2] For the character of the soils and the soil profiles see the Atlas of American Agriculture, Part 3, Soils of the United States.

is really derived from the B horizon, the soil is naturally mapped as a clay loam.

In many places it is plain that much of the B horizon has been removed, and indeed so far has sheet erosion proceeded in several areas that farmers are now tilling the C horizon of friable and disintegrated rock. It is not soil in the true sense, but it will hold water and provides something on which, with the aid of artificial fertilizers, a crop of cotton can be raised.

In the Black Belt of Alabama, despite the low relief and very gentle slopes that are characteristic of it, sheet erosion has been severe. The normal profile would consist of a heavy black clay above the white marl. In some abandoned fields, now growing up to scrub and rough pasture, the surface is however the white marl, all the black clay having been removed. The effect of this upon agriculture may be judged from the fact that in this region, once one of the greatest cotton-growing areas in the world, large tracts are now in pasture and support herds of cattle and flocks of sheep and the scenery is not unlike that of the prairies. In eight counties which constitute the heart of the Black Belt the acreage under cotton has fallen from 866,831 in 1899 to 540,950 in 1929. How far this change is due to erosion and depletion of the fertility of the soil and how far it is due to other causes, such as the competition of newer areas, is difficult to determine, yet it is plain that the former factors must enter into it very considerably.

*Gullying*

Gullying differs from sheet erosion in that the water is confined to certain definite channels, which, according to the stage of their development, may be from a few inches deep to more than 100 feet. Sometimes a whole hillside, after being cleared and cultivated for a short time, becomes a mass of shallow gullies not more than a few feet deep perhaps but in all covering a large surface. On the other hand there are now gullies more than 100 feet deep and perhaps twice as wide. As no accurate surveys have yet been made of them it is impossible to give any definite figures. Although all gullies start from surface run-off, their continued headward erosion seems to depend, in a number of cases, on undercutting by springs.

Near Milledgeville, Georgia, is a gully described by Charles Lyell in 1848.[1] Remarking first on the thickness of the disintegrated rocks in the Piedmont, he wrote: "Some very instructive sections of the disintegrated rocks have been laid open in the precipices of the recently formed ravines. Were it not that the original intersecting veins of white quartz remain unaltered to show that the layers of sand, clay, and loam are mere laminae of gneiss and mica-schist, resolved into their elements, a geologist would suppose that they were ordinary alternations of sandy and clayey beds with occasional cross-stratification. . . . Now and then . . . a large crystal of felspar, 8 or 10 inches long, is seen to retain its angles although converted into kaolin." Of this particular gully he wrote: "Twenty years ago it had no existence, but when the trees of the forest were cut down, cracks 3 feet deep were caused by the sun's heat in the clay; and, during the rains, a sudden rush of water through these cracks caused them to deepen at their lower extremities, from whence the excavating powers worked

[1] C. Lyell. 'A second visit to the United States.' London, 1849. Vol. 2, pp. 22–23.

*Shallow gullies in an abandoned field*

*Severely eroded pasture land*

*Eroded surface planted with strips of Bermuda grass*

*Gulley showing flocculated surface on shoulders*

*Gulley near Milledgeville with cavern in the C horizon*

*Gulley showing flocculated surface on shoulders*

*Gulley near Milledgeville with cavern in the C horizon*

backwards, till, in the course of twenty years, a chasm no less than 55 feet in depth, 300 yards in length, and varying in width from 20 to 120 feet was the result. . . ."

This gully has certainly enlarged considerably since Lyell visited it. At its lower end it has attained its local base-level and trees twenty or thirty years old are growing upon its sides and even in the floor, which is quite flat and covered with a deposit of sand. Here it is not more than 30 to 40 feet wide. Higher up it widens out and deepens; in fact the actual floor is one of very low gradient. The upper end of one of the branches is semi-circular and 200 feet or more in width, having almost vertical walls 80 to 100 feet or more high, though a considerable talus slope has accumulated at several points. Even here the solid rock is invisible. The most interesting part of this gully is the manner of its headward erosion. It is true that a number of shallow channels lead towards the head but they are covered with vegetation and show little evidence of carrying any considerable body of water. Moreover in the floor below there is no sign of any plunge pool such as would be expected from the descent of a large volume of water over the lip of the gully. That after heavy rains these gullies carry a large volume of water is evident from their U-shaped form lower down and from the fine water-washed sediment of the floor. They are the product of violent erosion. In the vertical wall at the head of the gully is a small cavern at the top of the C and below the base of the B horizon, *i.e.* it is in the friable disintegrated rock and just below the compact clay. It should perhaps be noted that hardly any of the A horizon now remains. This small cavern appears to provide a clue as to the way in which the gully is receding. After a period of heavy rain, the compact clay of the B horizon becomes saturated with water and this, percolating into the friable and disintegrated rock beneath, finds its movement easier and rapidly washes out this material, forming a cavern which becomes larger and larger until a portion of the B horizon above falls in. Although such caverns are not found in every gully of this kind, there is, on the other hand, little evidence of any streams flowing to the lip of these gullies and cascading over the more or less vertical walls which are characteristic of their heads. It seems then that the continued recession is due to the sapping of the disintegrated C horizon and the consequent falling in of the B horizon. Near this particular gully described by Lyell are other smaller ones, and an old negro farmer whose house lay near them said he never knew water run over the lip but that the walls seemed to cave in beneath and then the top fell in. He often lay awake at night during and after heavy rain and heard large masses falling in and wondered into which gully his house would fall.

Gullies of this deep ravine-like character exist all over the southern Piedmont in South Carolina, Georgia, and Alabama, and seem to be particularly frequent in the Cecil soil series where the contrast between the compact clayey B and the friable C horizons is most marked. When it is remembered that many of them cannot be more than 100 or 120 years old (since it was in the early part of the nineteenth century that this portion of the Piedmont was settled and cleared), the violent nature of the erosion becomes all the more remarkable. Not all of them originate on cultivated fields; one at least could be traced back to an old dirt road. Here it was plain that water

collecting in the hollow of the road had, in a short time, excavated a deep channel for itself, which again was receding backwards at a vertical face 20 or 30 feet high. This gully was again steep-sided and flat-floored and had evidently reached its local base-level though still actively receding at the head.

The beginnings of a similar gully could be seen where the water from a hard-surfaced road had been deliberately turned across a field. In this instance a peculiar form of sheet erosion was observable. The gully was not more than 4 or 5 feet deep, and it had somewhat rounded shoulders; all of it being cut in the compact clay of the B horizon. The surface of the shoulders displayed a thin, flocculated layer which would easily wash off during a period of heavy rain. In the succeeding dry period another thin, flocculated layer would form, to be washed off in its turn. In this way quite a considerable thickness of soil would be removed.

Another remarkable gully occurs in the soils of the coastal plain near Americus, Georgia, known locally as the "Grand Canyon." This must now be more than half a mile in length and near its head, which is semi-circular in outline with more or less vertical walls, it must be 150 to 200 feet in depth and perhaps 300 feet wide. In this instance, again, there was no definite evidence of any channels that might lead water to the lip of the gully nor of any plunge pool beneath. A somewhat smaller gully near by showed certain features which may explain the way in which these gullies recede. It has already been observed that in certain soils of the coastal plain there occurs, near the top of the C horizon, an indurated layer. It would seem that this has the effect of throwing out water which has percolated down through the B horizon. In this way the soft sands and clays beneath are rapidly washed away, until the indurated layer and the B horizon above it collapse.

It is impossible to do justice to the appalling results of soil erosion in the south-eastern states. An exploitive and wasteful system of agriculture has ruined the soil and this, in its turn, is reflected in the terrible conditions under which the majority of the farmers, both white and negro, are living. The south has been described as "a miserable panorama of unpainted shacks, rain-gullied fields, straggling fences, rattle-trap Fords, dirt, poverty, disease, drudgery, and monotony that stretches for 1000 miles across the Cotton Belt," and no better description could be found. Cotton, it seems, is doomed and radical changes must be made in the economy of the south-east if any improvement in the standard of living is to take place.

*Remedies*

In conclusion, it is well to consider what remedies can be found for so serious a situation. They may best be divided into two categories: those which involve changes in the use of the land and methods of agriculture; and those which aim at checking the further progress of the gullies. In the first may be placed reforestation, the reversion of arable land to pasture, and the introduction of new crops which may act as protectors of the soil.

It is now more than twenty years since the United States Government authorized the Forest Service to purchase land for reforestation in the neighbourhood of the water-sheds of the larger rivers, and the formation of national

and state forests is of importance in the more hilly and mountainous districts. But there are also large tracts which are and must remain in individual ownership, where steep slopes are cultivated. Such had better be reforested. This of course is a matter for the individual landowner, but the Government, through such bodies as the Tennessee Valley Authority and agricultural experiment stations, can and is doing much by demonstration and assistance to farmers to promote this desirable end.

Reforestation in an area like the south-east, in which so much of the land must surely remain agricultural, can be only one means towards checking soil erosion. A more balanced form of agriculture, in which pasture and crops such as clover play an important part, will go a long way to solve the problem, for it is essential that the soil be kept covered as much as possible. Yet some land must of necessity be used for such crops as cotton and corn, and improved methods of cultivating it must be extended. Such methods include proper terracing combined with contour ploughing which shall hold back the soil on slopes and check the too rapid flow of water; and check dams at the ends of terraces, to serve a like purpose; all these and other means must be more widely used if the ravages of soil erosion are to be checked.

How difficult the recovery of the land may be is shown by the fact that, in some cases, trees find it hard to get a footing in the hard and sterile clayey B horizon. In some cases the planting of strips of Bermuda Grass, taken from other fields, on an eroded hillside has been tried, but after two years the grass had hardly begun to spread.

The task of stopping the continued recession of gullies is by no means an easy one, and no really satisfactory method seems to have been found yet. Nature, no doubt, has her own methods if she is left alone, and there are several instances of gullies which had "healed" of their own accord and are now covered in trees and grass. But Nature's methods are slow and means must undoubtedly be found to accelerate the processes of healing. One such method is known as "bull-dozing," in which the vertical walls at the head of a gully are destroyed and a sloping surface constructed on which grass and trees can be planted. Black Locust trees are valuable for this purpose on account of their powers of rapid growth. Yet bull-dozing is not wholly successful, for heavy rains may pour down the slope and undermine what has been planted before it can get a secure hold.

Such are some of the features of soil erosion in the south-eastern United States. It presents problems of great magnitude which must be solved quickly. As this paper opened with a comparison of the clear rivers of the eighteenth century with the soil-laden ones of to-day, it is appropriate to close with the remark of Dr. Carl O. Sauer, Professor of Geography in the University of California, at a meeting where the problems of the south-east were being discussed, "When your rivers run clear again, your problems will be solved."

This paper is the result of a stay of six months in the south-eastern United States in 1936, during which time I was privileged to make a tour lasting some four or five weeks through the area concerned in the company of Dr. Carl O. Sauer, Professor of Geography in the University of California,

and a number of members of the Soil Conservation Service of the United States Department of Agriculture; and it is to them that I am indebted for much of the information set forth.

## Further References

Q. C. Ayres. 'Soil erosion and its control.'

L. C. Glenn. "Denudation and erosion in the southern Appalachian region." U.S.G.S. Professional Paper no. 72.

Much information on this subject may be obtained from various reports of the National Resources Committee and of the Tennessee Valley Authority.

The United States Department of Agriculture has issued a number of maps showing the character and extent of erosion in certain areas.

# THE RED SEA

LA MER ROUGE: l'Abyssinie et l'Arabie depuis l'antiquité. By ALBERT KAMMERER. Tome II. Les Guerres du Poivre—Les Portugais dans l'océan Indien et la mer rouge au XVI^e siècle—Histoire de la cartographie orientale. *Le Caire: S.R.G. Egypte* (*Mémoires, Tome XVI*), 1935. 14 × 11 *inches.* [*Part I*] xvi+262 *pages;* [*Part II*] 263–555 *pages; illustrations and maps.* £4 4*s.* [*London: Quaritch.*]

THE first volume, 'Les pays de la mer Érythrée jusqu'à la fin du moyen âge,' of this remarkable work, which appeared in 1929, has been reviewed (*Geogr. J.* 78 (1931) 87), and in general there is little to add about it. The incontestable importance of the work, its wide scope, and the lavishness of its production justify a more detailed examination of the present volume. As is indicated by the subtitle, it is specially concerned with the history of the Portuguese in the Orient. In the author's words, "Le fait nouveau du XVI^e siècle c'est qu'il débute avec des grandes découvertes dans l'océan Indien; et pour cette partie du monde les grandes découvertes sont uniquement le fait du Portugal."

The book is divided into two parts—"Histoire" and "Histoire de la géographie." The first traces the history of Portuguese expansion from 1430 to 1530; in this the great figures are Prince Henry, da Gama, Albuquerque, and d'Almeida. It also includes many lesser travellers, and sections upon the history during this period of the Red Sea, the Yemen, Abyssinia, and India. The four chapters of the second part are concerned with the cartography of the East before and during the great discoveries, the Reinel school, and the official cartographers down to 1560. The study of the history of geography is based almost exclusively upon the history of cartography, and it has been possible to reproduce many valuable maps, some of which are hitherto unknown. The book ends with "Tableaux synoptiques de nomenclature géographiques et d'histoire," which are always useful to students when accurate and reliable, and good indexes. Perhaps the outstanding feature of the book is the number of illustrations, of which there are 265, most of them full page, and 14 in colour. Among such reproductions the most remarkable are certainly those of the beautiful maps by the Reinels in the Bibliothèque Nationale, three of which have not been published before. It is a pity that the map of Northern Europe on the recto of the Atlas' first sheet is not given, as well as the map "Gé. AA. 640," in order to complete the set. Of the latter only the eastern half of the sheet of the Mediterranean is reproduced. The title, "La flotte portugaise de l'océan Indien et de la mer rouge," given to the reproduction of part of the North Atlantic on the verso of the first sheet of the Atlas, is meaningless. The part reproduction of two hitherto unpublished maps, one a Portuguese of after 1535, and a sheet of a Spanish atlas of about 1560 (Pl. LIII and LIV), is also noteworthy.

Another feature of the work is the great amount of bibliographical information, some of which was little known, and is thus very useful to students of oriental history. But caution is necessary, for the book contains many errors and inexactitudes.

Although it is stated on p. 258 that the ambassador Mathew arrived at Lisbon in 1513 and left for the Orient in the spring of 1515, on p. xii we read that he stayed in Lisbon for "several years." Actually he left India in January 1513, wintered in Mozambique, arrived at Lisbon in February 1514, and sailed for India again with Duarte Galvão and Lopo Soares de Alvarenga in April 1515.

On p. 257 the "voyage of Mathew to Rome" and his interview with the Pope is described, but it is very improbable that he went to Rome, for there is no mention in any Portuguese chronicle or document of so important a mission. The only basis for the assertion is a document, quoted by de Caix de Saint-Aymour, on some questions put by Paul III to Mathew, which is a later copy of an undated document. As Paul III ruled from 1534 to 1549 and Mathew died in 1520, Kammerer thinks that there is a mistake in the name of the Pope, and that it should be Leo X (1513–1521); but there is probably a confusion with the names of Alvares or Bermudes, who were received by Paul III as ambassadors of Prester John.

Among several inaccuracies in Chapter VII referring to Mathew it is said that "il obtint à grand'peine, vers la fin de 1512, d'être admis devant le vice-roi" (p. 251). In the first place Albuquerque was never a viceroy; secondly, as soon as he knew that Mathew was a prisoner of the Moslems at Dabul, he immediately sent to release him; thirdly, when Mathew arrived at Goa, Albuquerque wanted to receive him at once, but Mathew refused to disembark without the honours which, he said, were due to his rank as ambassador. This is described by Góis on pp. 37–38 of his *Legatio*, frequently quoted in the present work. There are other inaccuracies in this connection on p. 272.

It is stated on p. 6 that the famous pictures of Nuno Gonçalves (reproduced Pl. II) are at the "palais du patriarche de Lisbonne," but for about thirty years they have been in the Museu de Arte Antiga at Lisbon. On the same page it is said that Prince Henry "appela auprès de lui Jacomo de Mallorca, spécialiste de la science nautique," and on p. 43 that he was "engagé comme astronome" by King Afonso V, about 1412. In reality Prince Henry engaged him as a cartographer about 1420, and Afonso V was not born until 1432. On p. 8 it is said that the copy of the book of Antonio Galvão, published in 1563, is "unique"; but there are at least two more copies in the Biblioteca Nacional at Lisbon and another in the Biblioteca Nacional at Madrid.

The voyage of Covilhã—who left for the Orient in 1487—and the information he sent to Portugal after his visit to Aden, Ormuz, Cananor, Calicut, Goa and Sofala, has at least as much importance in the history of the discovery of the maritime route to India by da Gama, as the first voyage round the Cape of Good Hope made by Dias at the same time (1487–1488). It should therefore be accurately described. For the account given on pp. 11 ff. and the route as shown on the sketch-map, should be substituted the following summary, based upon the sole authority, the "Verdadera informaçam" of Francisco Alvares, who obtained the information from Covilhã when they met in Abyssinia (1521–1526). Covilhã and Paiva went from Cairo, *via* Tor and Suakin, to Aden, where they separated, Covilhã travelling to Cananor, Calicut, Goa, Ormuz, and probably to Aden—though this is not stated by Alvares. Thence he went to Sofala, perhaps in 1489, and back again to Aden, Tor and Cairo, where he arrived possibly at the end of 1490 or the beginning of 1491. After hearing of Paiva's death he was intending to go back to Portugal when he was found by the two Portuguese Jews who were searching for him with letters from the King. Covilhã decided then to go to Abyssinia, and sent the Jew Joseph with a letter to the King, in which he reported on his voyage, and the map which he had brought from Portugal. On this map he had marked and written down the names of all the places he had visited. This last information is given only in an unnoticed remark in the first edition (1551) of the first book of Castanheda's chronicle, of which only three copies are known. Then Covilhã went with the other Jew to Aden and Ormuz, where he left him, came back to Aden, visited Jeddah, Mecca, El Medina, and Mount Sinai and Tor, whence he sailed for

Zelia, arriving at the end of 1492 or the beginning of 1493, and started for Tegulet, where the Negus Iskander then was.

Although it is impossible to continue this analysis page by page, a few more remarks should be made. Kammerer pays a high tribute to the Portuguese epoch in the Orient, though he also writes that "Le mobile principal du Portugal était un étroit esprit de jalousie et de concurrence vis-à-vis des républiques italiennes," a work of "corsaires et pirates," mainly made "au moyen du canon." It is also an exaggeration to say that in India the Portuguese priests outnumbered soldiers and civilians (p. 292). On p. 452 it is said, "Dès 1523, la *Casa de Contratación* avait été transférée de Seville à la Corogne." The *Casa* was never transferred from Seville; what happened was that after the arrival of Sebastian del Cano in 1522, another *Casa de Contratación* was created in Corunna, which co-existed for a short time with that of Seville. After quoting on p. 253 the first edition of Góis' *Legatio*, printed in 1532 at Antwerp, it is noted in the "Addenda et Corrigenda," p. 470, that that is an error, and that this edition does not exist; there is however a copy of the Antwerp edition of 1532 in the British Museum.

In the reviewer's opinion the dates assigned to some of the maps require revision, *e.g.* the *Insularum illustratum Henrici Martelli, circa* 1492, not "1489 ou vers 1490"; the Portuguese map in the Bibliothèque Nationale ascribed without reason to Columbus, 1500 or later, instead of "début de l'année 1492"; and the map of Canerio, 1505–1506 or later, instead of 1502. In Appendix II it is stated that on the Cantino map the only name on the African coast of the Red Sea is "Maçua." This is not so; the only words written on this coast, in the place corresponding to Suakin, are, "Cabacuym em esta ilha ha cavallos e cobre." The maps of Francisco Rodrigues are not in Lisbon; when Santarém reproduced them they were in Paris. They can be dated a little after 1512, instead of "vers 1520." Pl. CLXVII reproduces, from Santarém's Atlas, the middle part of Weimar's anonymous map of 1527, as though it were the whole. It is now established that this world-map was drawn by Diogo Ribeiro. In 1929 it was reproduced in its entirety, in 24 large plates, by P. Gottschalk—*The earliest diplomatic documents in America*. In spite of the great display of maps before 1530, Kammerer did not know of the Portuguese map of the Indian Ocean, with the Red Sea, of *circa* 1509(?), in the Bibliothek zu Wolfenbüttel, which is of great importance in the history of cartography of the Orient. The *Tratado del esphera y del arte de marear*, of 1535, is not by Ruy Faleiro, as quoted on p. 51, but by his brother Francisco Faleiro. On p. 442 also appears "Ruy Faleiro et le fils de ce dernier," this son perhaps meaning his brother. Afonso de Albuquerque was fifty-one or fifty-two years old when he died, and not seventy-three (p. 210). Simon de Alcomzaba and De Soto Mayor (p. 442), are given as two different persons, though the names refer to the same man, called Simão de Alcaçova de Sotomaior or Simon de Alcaçaba de Soto Mayor; the licenciate Calçadilha, bishop of Vizeu, or Diogo Ortis de Vilhegas (pp. 12 and 44) is also referred to as two different persons; and Pero Delpoam (p. 251) is written for Pero de Alpoim.

These inaccuracies, unhappily appearing too frequently throughout the book, show that although it can be of great help to students, details and references require to be checked. A. Z. C.

# REVIEWS

## EUROPE

OUT OF DOORS IN ENGLAND. By JAMES TURLE. *London: Constable & Co.*, 1937. $7\frac{1}{2} \times 5$ *inches;* vii + 306 *pages; illustrations.* 7*s* 6*d*

This is neither a guide book nor a travel book. It is the jottings of a man who knows the south country well and is fond of country people, of birds, and of flowers. There is much country lore to be learned from it, but the method of presentation seems out of keeping with the subject. "If you have read as far as this," Mr. Turle writes on p. 81, "you will be used to jumping from one thing to another, and from one place to another." That is true, and by p. 307 the reader should have the agility of a well-trained pedestrian; but it is doubtful if the countryside is best presented in these kaleidoscopic changes of place and subject. They tend to distract the reader and to hide the author's real love and knowledge of his subject. Quotations from Evelyn, Jefferies, and others are introduced appropriately but somewhat clumsily. The book is well illustrated by Mr. Taylor's photographs, but unfortunately the captions to them give little or no indication of where they were taken. T. S. W.

THE NATIONAL ROAD BOOK. By R. T. LANG. Volume II. East Anglia and East Midlands. *London: Methuen & Co.*, 1937. $8 \times 4\frac{1}{2}$ *inches;* xxiv + 782 *pages; illustrations and map.* 15*s*

This is the second of a series of five volumes which will deal with the whole of England and Scotland: the West Midlands and Wales, the North of England, and Scotland are to follow. It is a compilation which will doubtless be received by motorists with at least as warm a welcome as volume I on the South. The ground now covered lies between the Humber and the Bath Road, east of the main road from Goole by Doncaster, Worksop, Derby, Nuneaton, Banbury, and Oxford to Newbury: a region rich in aesthetic and historical interest. Painstaking investigation makes it the best road companion to date, and the linen-backed pocket map with numbered roads, A roads in black and B and unclassified roads in red, will stand much handling. In the text the left column concentrates on the road, with mileage, and some obvious landmarks to mark one's whereabouts. This detail could hardly be bettered. With his car companion on his left noting such points, the driver can go confidently forward. The way through towns is clarity itself: all road numbers are given at the head of each route. The right-hand column is a mine of accurate information, historical, antiquarian, and literary. Indexes supply all the knowledge a traveller, apart from a specialist, could possibly wish for. The reviewer has tested the pages on many of the main routes and cross-country roads with which he is familiar, and found them never to fail. Not only is the volume valuable as a guide on the road, but very entertaining to a reader in his chair as reminiscent of journeys done. It is a book which every motorist going into new country should have with him.

S. E. W.

DENMARK: Kingdom of reason. By AGNES ROTHERY. *London: Faber and Faber*, 1937. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xii + 276 *pages; illustrations and sketch-maps.* 12*s* 6*d*

This is not a book for those who already know Denmark well, nor for those who wish to put their acquaintance with the country on a serious footing; but for the casual visitor who likes to feel that he has read something about the places he visits and for the stay-at-home who desires a glimpse of new countries from his armchair Miss Rothery's book is just what is needed. Lightly as a butterfly

she flits from tower to tower, from fact to fancy, from history to pre-history, binding the whole together with a thread of visual and literary experiences which may bewilder at times by reason of their incompleteness, but which cannot fail to impress by their brilliance.

Miss Rothery is full of enthusiasm for everything in Denmark, and those who are tired of hearing the Scandinavian countries described as "gloomy" will be grateful to her for a cheerful book about a cheerful country. There are lively descriptions of town and country-side, of social services, of schools, of agriculture and shipping, to mention only a few of the topics which the energetic authoress has embraced. There is a chapter on Greenland, the Faroe Islands, and Iceland, which seems somewhat misplaced and reminds one of the sixteenth-century geographers, who felt bound to mention everything they had heard of those countries though they had seldom visited any of them.

The chronological outline at the end of the book adds to it some misleading statements, and the bibliography, in spite of its imposing proportions, is not a scholarly compilation and will be useful only to those unable to read any language but English. M. S.

FINLANDIA E STATI BALTICI. By Elio Migliorini. (Pubblicazioni dell' "Istituto per l'Europa Orientale." Seconda serie. XXX.) *Roma*, 1937. 9×6 *inches;* 218 *pages; illustrations and maps.* L.20

This concise yet comprehensive work supplies the student with all the essential data as to the geographical significance, economic conditions, and political outlook of Finland and the Baltic States. It contains much reliable and up-to-date information, not otherwise obtainable in the Italian language and not, collectively, easy of access in English, French or German. The author, having himself visited the countries described, is able to contribute the personal touch without which it is difficult to awaken interest. The arrangement of the work is admirable. The mode of treatment and sequence being practically identical in the description of each country, a detailed index becomes less indispensable, although, for purposes of reference, the value of the book would have been enhanced thereby.

The account of each country is introduced by a short summary of its previous history, related clearly and without bias. The picture emerges of a race, or races akin to one another, each with a strong individuality, held for centuries subject to greater powers, under circumstances in some cases beneficent, more often humiliating or even tyrannical. Finally, after the Great War, each succeeded in establishing its autonomy, evolving gradually its own form of government, since which time its development has taken place steadily and along individual lines. The origins of the various races are traced as far as possible and their affinities set forth: that for instance between the Finns and the Ests who have almost a common language allied in Europe only with that of Hungary. The distinctive strains of ancient nearly-related Indo-European racial types, inhabiting the remainder of the territory, are shown to be incorporated into the States of Latvia and Lithuania.

The position of each country is then dealt with and the nature of its boundaries, the latter having an important influence on its political life. This is the case particularly with Lithuania as shown by the diagram on p. 168. Then follows a brief description of the physical conditions. The countries in question are mainly dairy-farming or agricultural except Finland, where the forests, alongside but exceeding in value all the other industries, form a great source of national wealth. The geological structure also sets Finland apart from the others as a country of ancient and hard rocks situated mainly within the

erosion-territory of the Great Ice sheet, while the Baltic States, formed of later sedimentary material, come well within the accumulation-territory of the Glacial Period.

Sections 3, 4, and 5 in each case deal with political and economic structure. In discussing the distribution of the population, mention is made of the typical old-fashioned farmhouse, which has in each country an individual character. Economic conditions are shown to have greatly improved since the introduction of autonomy; and industries have been developed and expanded, especially in Finland and Estonia, where the co-operative system has been most successfully introduced. In the Baltic States complications of ownership at first retarded development, but the passing of special agrarian laws has ameliorated the lot of the peasants although often to the detriment of the former proprietor, the dispossessed German baron. Section 6 describes in a few words the prevailing conditions in each country at the present time.

The bibliographical notes concluding each division of the book are as complete as possible and give precise indication of the aspects of the subjects specially treated in each work. The statistical tables at the end of the book will be useful for reference. The sectional maps and plans of towns are good, but the larger maps and diagrams have been too much reduced. The photographs though few are well chosen, but the illustrations are not numbered. The book is to be recommended both for thoroughness and for lucidity of style.

E. G. W.

## ASIA

THE ROAD TO OXIANA. By ROBERT BYRON. *London: Macmillan & Co.*, 1937. 8×5 *inches;* x+342 *pages; illustrations and sketch-map.* 10*s* 6*d*

Mr. Byron's book is an interesting account of his journeys through Persia, Afghanistan, and Afghan Turkistan. His style is vivid, and although he is by no means the first European to visit most of the places which he describes, he does succeed in conveying the fascination of these countries with their strange contrasts of bare deserts and beautiful mountain valleys. It is obvious that the architecture interests Mr. Byron more than the people, with whom he has not a great deal of sympathy. As a result of this his descriptions of the palaces, mosques, and historical monuments are too detailed and technical for the ordinary reader, who will probably turn with relief to the more human account of a night spent in a Persian village or the trials of an ancient lorry. Occasionally the book is disfigured by an ill-timed flippancy, and there is too much insistence on the diseases from which he and his companion suffered. There are some really beautiful photographs and two sketch-maps. S. E. H.

TRIUMPHANT PILGRIMAGE: An English Muslim's journey from Sarawak to Mecca. By OWEN RUTTER. *London: George G. Harrap & Co.*, 1937. 9×5½ *inches;* 278 *pages; route-map and portraits.* 10*s* 6*d*

Eldon Rutter published ten years ago one of the best books written about the Meccan pilgrimage and life in the Holy Cities of Islam. His namesake is the author of one which is far from being in the same class. It is stated to be "a true account of one of the most remarkable journeys in recent years. It tells of an Englishman who became a Muslim from profound conviction and whose dream it is to restore the ancient faith to its pristine simplicity and to unite the sects of Islam into a single body which shall be a tremendous power for peace in the world." It should, in fairness to the author, be said at once that the prophet proclaimed in these words is not himself. He did not perform the pilgrimage, but has written this book as proxy for one who did, "David Chale"—a name

which is itself only a pseudonym. But why such mystery? The "veiled prophet" is a favourite device in Islam, and veiled prophets can come from Kuching as well as from Khurasan.

Half the book is taken up with the thrilling account of David Chale's journey from Sarawak to London, including a visit to a Parisian coiffeur to modernize a Malayan wife whom, as is confessed, he only married to further his scheme of getting to Mecca. He could not get a *visa* for Mecca anywhere nearer than London. "It's as hard as all that." Mr. Zada, of the Arabian Legation, would perhaps not recognize the account of his interview with David Chale. In the course of time the hero of the story reached Jidda, his wits duly "sharpened by vicissitude," while some of his fellow-passengers on s.s. *Talodi* had landed at Yanbu to pit *their* wits against the "bears and tigers" on the road to Madina.

At Jidda David Chale endured the torments of hell while the Arabian bureaucracy, not unlike bureaucracies in other parts of the world, dealt with his application to proceed to Mecca. He spent part of the interval negotiating the purchase of a female slave, guaranteed to be a paragon of beauty, in order to have the merit of freeing her on the field of 'Arafat. He had however refused to complete the bargain on finding the lady to be aged and hideous by the time that, after the usual interviews with Amir Faisal and the King, formal permission was accorded him to proceed to Mecca. Another European, an Austrian, had previously received similar permission, but it had however been refused to an American lady.

So Chale proceeded to the pilgrimage. At 'Arafat "there came a stir in the camp as the King's bodyguard, mounted on camels, preceded the royal car, which halted at the foot of Mount 'Arafat. The King, accompanied by an Imam, climbed to the summit. His tall form was silhouetted against the sky as he stood there by the granite pillar, but the words of the Imam, as he preached the sermon . . . could not reach the great multitude below." For sheer imagination it would be hard to beat this eye-witness's account of what happened at 'Arafat. In fact the king did not—he never does—arrive in 'Arafat in a car, but in the traditional way by camel. Neither the king nor the Imam ascended to the summit. And no sermon was preached on the mount. Perhaps all these things would happen if the new prophet had his reforming way. But they do not happen now, and the hero of "one of the most remarkable journeys of recent times" seems to have been singularly ill-equipped for such a task. H. St.J. B. P.

TRANSACTIONS OF THE GLACIAL EXPEDITIONS. Vol. I. Pamirs: the north Pamirs and Fedchenko Glacier. xxxviii+486 *pages. Leningrad: U.S.S.R. Committee of the Second International Polar Year at the Central Administration of the Hydro-Meteorological Service*, 1936. 9×6 *inches; illustrations and maps.* 18 *roubles*+2 *r. for binding.* [In Russian; with English summaries.]

This is the first of six volumes of the Transactions of the Glacial Expeditions organized by the U.S.S.R. Committee of the Second International Polar Year. The present volume begins with a concise survey of the results achieved by the various Russian expeditions sent in 1932 and 1933 to the Urals, the Tien Shan, the Pamir, Western Tajikistan, and the Caucasus. Apart from this general introduction by N. P. Gorbunoff and V. I. Popoff, the book consists of detailed reports on the meteorological, hydrological, photogrammetrical, and geomorphological work of the Pamir expedition, describing in particular the formations, conditions and changes of the Fedchenko glacier. The eleven articles dealing with the points mentioned are contributed by the leader of the expedition, V. I. Popoff and by O. A. Spengler, F. G. Dorofeyev, V. E. Gordienko, K. M.

Gromoff and K. K. Markoff, who took part in it and were concerned with the research. The book as a whole reflects vividly the difficult work carried out during two successive seasons, from August to October 1932, and during the same months of the following year, 1933. In many respects the scientific reports are still of a merely provisional nature, for the accounts were completed in 1934 before the authors could exhaust the rich materials they had collected. It was at the time also impossible to make use of any investigations by the Observatory left behind on the Fedchenko glacier at the height of 14,000 feet.

Besides numerous maps, sketches, and tables, the book contains about 120 views of the regions visited by the expedition, and it is a great pity that most of these photos are reproduced very inadequately.

English summaries, some of them sufficiently extensive, are annexed to each chapter, making the book to a certain extent accessible to those who have no knowledge of Russian. L. L.

AIR OVER EDEN. By "H. W." and SIDNEY HAY. *London: Hutchinson & Co.*, 1937. $9\frac{1}{2} \times 6$ *inches; 292 pages; illustrations and map.* 18*s*

This is not another flying book as the title might suggest, but is the story of 'Iraq admirably told by two authors who have studied the country from every angle and have taken full advantage of the wider view from the air. The history of 'Iraq is traced in a most colourful and interesting manner from the dawn of time to the present day, when 'Iraq has reached a position of paramount interest to the modern world as the junction of the air routes to the East, her great oil resources ready to supply the needs of modern transport and her ancient history being dug up from the sands of the desert daily by archaeologists of many countries.

It is one of the better travel books of recent years, and the illustrations have been greatly enhanced by many views from the air. D. F. M.

LEAVES FROM THE JUNGLE: Life in a Gond village. By VERRIER ELWIN. *London: John Murray*, 1936. $9 \times 5\frac{1}{2}$ *inches; 244 pages; illustrations.* 9*s*

Mr. Elwin's notes and introduction provide much information on the origin, folklore, and present conditions of the Gonds, a primitive, disease-stricken but friendly people living in the jungle in the Central Provinces. He lived and worked at Karanjia, where the Society for the Service of the Gonds, whose members are drawn from various religious communities, had established its headquarters in 1932. The diary of the author's four years of residence there is outspoken, and on occasion unexpectedly flippant, but the reader is never permitted to forget that the conditions described are no laughing matter. Most of the time Mr. Elwin is concerned with the Gonds, with every aspect of whose life his work, as doctor, teacher, and farmer in turn, brings him into touch. Many other figures however cross his pages, from the local police to leaders of Indian politics, and they are all equally shrewdly observed and portrayed.

J. P. H. M.

## AFRICA

LE MAROC, VU DE PARIS. By PHILÉAS FOGG. *Paris: Larose*, 1937. $7\frac{1}{2} \times 4\frac{1}{2}$ *inches; 254 pages; illustrations and sketch-maps.* 15*fr.*

This is a brilliant and most informative little book. The author's name is suppressed and its place taken by that of the character created by Jules Verne, and known to every Frenchman. But it is obvious that the book has been written by a very cultured and highly-placed French official who is well informed on Morocco both through residence and wide reading. It is a criticism of ill-informed metropolitan and armchair critics of the French officials and traders

who are running Morocco *in* Morocco, and is couched in semi-satirical vein. It is meant both to "rap" these critics "over the knuckles" and to get them to see the error of their facile pronouncements and ill-judged attitude. The book is very readable but is also concise and accurate, and full of astute and wise observations on the conditions as seen through the eyes of French officials and Frenchmen engaged in trade and administration on the spot.

The author has a sound conception of both geography and history, and the penetration of some of his geographical and historical generalizations is remarkable. Those who already know Morocco well will read this little book with much profit and certain pleasure. W. F.

RESTLESS JUNGLE. By MARY L. JOBE AKELEY. *London: George G. Harrap & Co.*, 1937. 9×5½ *inches;* 316 *pages; illustrations and sketch-map.* 10*s* 6*d*

Without any but the most humanitarian interests Mrs. Akeley searches darkest South-East Africa, with an especially observant eye for the strange and eventful in the characteristics and life of its primitive inhabitants—both man and beast. There is restlessness in the mood of the author as well as in the landscape which she describes, and one is reminded by these pages of other travellers' tales, offering impressions equally brilliant in their graphic quality and in their variety, if also rather superficial. When describing the zoological wealth of the Kruger National Park, Mrs. Akeley's touch is surest and most convincing. She retains a keen eye for descriptive detail, but, on the other hand, when pausing, a little breathlessly, to mention some of the grim problems of the country's destiny there is quite inadequate appreciation of the rapidly changing social landscape of the land of the Bantu. In an introductory reference to the discovery of South Africa, which has little or no association with succeeding chapters, the award to the Cape of Good Hope of southernmost position on the continent is an unfortunate one for an experienced map user to make. But the reader will be willing to overlook all deficiencies in the enthusiasm inspired by colourful and dramatic prose. The excellence of the photography, achieved under great difficulties, demands recognition. W. F.

LE PACTE DE SANG AU DAHOMEY. By PAUL HAZOUMÉ. *Paris: Institut d'Ethnologie* (*Trav. et Mém. XXV*), 1937. 10½×7 *inches;* viii+170+vii *plates; illustrations.* 37*fr.* 50 (*Etranger* 56*fr.* 25)

In this work M. Hazoumé shows that the pact of blood-brotherhood in Dahomey is an essential factor in many undertakings where the establishment of a relationship of loyalty and mutual support is necessary. The relationship is established by esoteric ritual, the symbolic significance of which is described in detail by the author. An individual who enters into this pact contracts obligations towards his blood-brothers which, according to the author, are even held to outweigh those towards his own family. The faithful discharge of these obligations is sanctioned in myth and legend; is backed by public opinion and moral feelings; and above all, is supported by the beliefs in terrible supernatural punishments which are believed to fall upon those who betray their trust.

Several important functions of the institution become apparent from M. Hazoumé's record. The historical and legendary accounts show very well the part which it played in warfare and political intrigue. The pact included obligations of an economic order, of help and succour in time of need, and imposed duties not only towards the blood-brother, but, upon his death, towards his orphaned children. Finally, adultery with the wife of a blood-brother constituted a breach of the pact, which thus served as a sanction for sexual morality. In this connection however the entry of a woman into the pact includes obliga-

tions of a sexual order, though the author does not state clearly how far this constitutes a disruptive element in community life and how far it is a generally recognized form of sexual license.

As an ethnographic document however this work is open to criticism on several points. There is no record of the conditions of observation, so that it is impossible to tell how far the customs recorded were actually observed, how far they were merely the statements of informants, and in the latter case what steps were taken to verify them or to corroborate them from other sources. For example, there are statements concerning formulae and ritual which were said to be surreptitiously carried out during the ceremony of the pact itself in order to repudiate it and avoid the evil consequences of treachery. But what was the native reality behind these statements of "mental reservation ritual"? How far was it actually carried out? Were the statements about it received from informants who claimed to have used it themselves or from people who accused others of doing so, or merely as casual gossip? On this and many other matters the documentation is unsatisfactory, and this is particularly marked when the author suggests generalizations without citing evidence either of actual observations or of native statements. The spectacular, esoteric, and ritual aspects of the pact are stressed at the expense of its more mundane phases, particularly its utilitarian function of ensuring economic co-operation, a subject which is very cursorily treated. The result is a picture of the old kind of pre-logical native dominated by the bizarre customs generated by his suspicion and superstition. This is unfortunate, since the book contains much valuable information, which would acquire much greater scientific significance if M. Hazoumé would re-consider it in the light of modern anthropological problems and methods of field-work. R. P.

## POLAR REGIONS

BRITISH POLAR YEAR EXPEDITION, FORT RAE, N. W. CANADA, 1932–33. Volume I. Discussion of results. Meteorology, terrestrial magnetism and aurora, atmospheric electricity. xiv+336 *pages; illustrations and maps*. Volume II. Tables. x+228 *pages*. Published under the direction of the British National Committee for the Polar Year, The Royal Society, Burlington House, London, 1937. 12½×10 *inches*

The British Polar Year expedition to Fort Rae, 1932–33, was part of the contribution of this country to an internationally organized programme of observations at a circumpolar network of stations, carried out, appropriately enough, in the jubilee year of a similar enterprise which became known as the First International Polar Year.

A general account of the life and work of the expedition was given in a lecture by Mr. (now Dr.) J. M. Stagg, the leader, and published in *Journal* of the Royal Meteorological Society for July 1934. The results of observations—meteorology, terrestrial magnetism and aurora, and atmospheric electricity—are now presented in two volumes.

Vol. I gives the discussions by members of the expedition—meteorology by W. R. Morgans, terrestrial magnetism and aurora by J. M. Stagg, and atmospheric electricity by P. A. Sheppard. (The surveying work, it may be mentioned, was under the charge of A. Stephenson.)

The observations of 1932–33 were made at Fort Rae, N.W. Territory, on the Marian Lake extension of the Great Slave Lake, in lat. 62° 49′ long. 116° 41′ W., and also some at Old Fort Rae, 15 miles to the south-east, the site of the British observations of 1882–83, so that the recent and the earlier observations in terrestrial magnetism could be linked together. The two sites also gave a con-

venient base-line for the determination of the position of aurora by simultaneous photography, a line of research that has been developed in recent years.

The period between the two expeditions is marked by some notable advances in instrumental technique: an instrument has been perfected for continuous registration of wind velocity and direction, as also have self-recorders for other meteorological elements; magnetographs designed for the work of the Second Polar Year enable magnetic disturbances to be timed to a second or two. The transfer of some of these instruments from the more genial climates of their origin to Fort Rae, climatically more extreme (range of temperature 87° F. to −44° F.) and magnetically enormously more disturbed, involves certain instrumental difficulties, and it is much to the credit of the expedition that these were successfully dealt with, and such a complete series of observations made available.

The exploration of the upper atmosphere by small balloons carrying meteorological instruments began some ten years after the first Polar Year; a few years later the existence of what is now generally known as the stratosphere was recognized, and since then the search for the secrets of weather processes has been continued more and more vigorously. Thus the upper-air research is an important part of the Polar Year work. The problem of generating hydrogen on the spot was solved and from Fort Rae 385 pilot balloons were released, giving a valuable survey of the upper winds, and from 27 meteorographs sent up two records were retrieved, giving data of temperature up to 17 kilometres altitude. The small number retrieved is inevitable in such sparsely populated territory and for the future the solution seems to lie in the use of the radiosonde, from which automatically transmitted W/T signals can be transformed into data of temperature and pressure, and the recovery of the instrument is not essential.

Vol. I gives first a general account of the work and then a thorough discussion of results under headings temperature, pressure, and the other meteorological elements, on the lines of previous polar work. Temperatures are given in Centigrade degrees, less familiar in this country, but internationally more acceptable. The opportunity has been taken of discussing also the results of 1882–83, a task which had been overlooked before. The data of the earlier year are somewhat crude by modern standards, but it has been necessary to take them at face value, and some doubt remains, for instance, as to what corrections were applied to the original barometric readings. In 1932–33 however much care was given to control observations for the reduction of the autographic records and the methods described leave no doubt about the reliability of the data. The complete course of temperature and pressure during the year 1932 August 1 to 1933 August 31 is given on meteorograph diagrams along with symbols for wind and weather. The discussion of terrestrial magnetism and aurora, which occupies rather more than half the volume, opens with detailed description of instruments and manipulation. This section, dealing partly with instruments which are so modern that a hard search would be required to find an account in the text-books, is particularly valuable, and inspires confidence in the reliability of the results. Besides the modern instruments the expedition used a Kew magnetometer and dip-circle, to make observations at the site of 1882–83 and to serve as a standby in case of misfortune with the other instruments. Fortunately the latter was avoided, and the new Copenhagen variometers, aided no doubt by sympathetic manipulation, appear to have been a conspicuous success. Besides the determination of accurate values from the records the discussion is directed particularly to the interpretation, on the lines of modern theory, of magnetic disturbance and its association with aurora, in

regard to both of which phenomena Fort Rae is well sited, being apparently on, or just within, the zone of maximum aurora. Students of the subject will find themselves well repaid by a careful study of Dr. Stagg's penetrating analysis of the data. As regards the inter-relation of aurora and terrestrial magnetism, while such inferences may be made as that the degree of magnetic disturbance is generally greater when aurora is ray-structured than when it is of the quiet homogeneous arc or glow form, the general conclusion is reached that the two phenomena are only loosely associated, and problems remain for future study.

The observations in atmospheric electricity included continuous autographic registration of potential gradient and daily observations of other elements, all of which are discussed, particularly with reference to the relation of atmospheric turbulence to their variations. A small effect of auroral activity in depressing the potential gradient near the earth's surface is traced, and is attributed to the penetration of the atmosphere at auroral levels by particles carrying, on the whole, a negative charge.

The text is well illustrated by diagrams and some photographs; a few minor misprints have been noted and some few of the diagrams are difficult to read, having been reduced considerably for printing, but on the whole this volume is an excellent production. It is intended to publish further discussion, including the results of auroral photography. The inclusion of an index in any further volume would be of value.

Much of vol. II has apparently been produced by a process involving the photography of typewritten material. Tables to the number of 287 are given, including the hourly values of various elements from autographic records, basic tables of observations, and tables of frequencies and mean inequalities of various phenomena, altogether a vast amount of information, the preparation of which must have entailed much arduous work. By these tables the phenomena observed at Fort Rae and their variations can be compared with simultaneous events at other places.

The aim of the Polar Year activities may be stated as the provision of comparable data for forming synoptic pictures of phenomena in the high latitudes where observations are normally few, as well as the discussion of results at individual stations, and it is pleasant to see in these two volumes a worthy contribution by the British Expedition to Fort Rae. S. T. A. M.

## PHYSICAL AND BIOLOGICAL GEOGRAPHY

EROSION OF SOILS. Edited by A. M. Pankov. *Moskva-Leningrad: Academy of Sciences, U.S.S.R. (Dokuchaiev Soil Institute)*, 1937. $10\frac{1}{2} \times 6\frac{1}{2}$ *inches; 354 pages; illustrations and map.* 5*r.* 50*k.* (*binding* 50*k. extra*). [In Russian]

Although the late Professor A. M. Pankov of the Dokuchaiev Soil Institute is not mentioned on the title page of the collection of articles recently published by the Institute, this book is nevertheless intimately connected with his name. Besides being the editor, Pankov contributed several articles, and after his death (in June 1936) the publication, which he had not been able to complete, was dedicated to his memory. An obituary by L. I. Prasolov outlines Professor Pankov's activities at the Institute and gives a bibliography of his publications.

In keeping with his theoretical work and practical experience, one of Professor Pankov's articles in this volume is devoted to the problem of normal denudation and erosion of soils in general, the second one deals with soil erosion in certain parts of the central black-earth region of Russia, and the third article consists of a questionnaire intended to provide the Institute with material for its research work.

Apart from this the book contains thirteen articles contributed by eleven authors. Like Pankov's articles they are symptomatic of the growth and development of Russian research work on soil erosion. Many of them describe the actual situation in various parts of the U.S.S.R., both in Europe and in Asia; in the Vyatka region near Kirov, in Kirghiz and Uzbekistan, on the river Ural, and in Georgia. Some of the articles dealing with general problems of soil erosion are likewise based on Russian experience: in one case for example the influence of erosion on harvest is discussed entirely on the basis of soil conditions in the Crimea. In other cases similar problems are discussed in close connection with the experimental work carried out by Russian scientists and institutions, in particular by the Experimental Station in the region of Kursk.

Parts of the book are provided with tables, maps, and views. A number of articles contain bibliographies. The latter have one common and significant feature: as far as foreign literature is included the titles are with two exceptions throughout English, and predominantly American. L. L.

## ECONOMIC AND HISTORICAL GEOGRAPHY

TERRAE INCOGNITAE: eine Zustammenstellung und kritische Bewertung der wichtigsten vorcolumbischen Entdeckungsreisen. Band I. Altertum bis Ptolemäus. Band II. 200–1200 n. Chr. By RICHARD HENNIG. *Leiden: E. J. Brill*, 1936–7. 10×6½ *inches;* x+384, x+400 *pages; illustrations. Gldr.* 6.00 *each volume*

Dr. Hennig's extremely comprehensive work is a valuable contribution to classical and mediaeval geography. His plan is to cite the texts of the original authorities for the outstanding achievements and problems of exploration, and to follow each extract with a critical discussion of the points it raises. The texts are given in German translations, with notes on the editions employed. He is not therefore concerned with the niceties of emendation or translation, but with geographical interpretation. His commentaries, which often extend beyond the immediate problem under discussion, summarize the views of earlier critics, for the most part German scholars, and then outline his own conclusions. Supplemented by the index of proper names, the work forms virtually an encyclopaedia of ancient and mediaeval exploration.

The first volume forms in effect a commentary upon a great part of the material contained in Ptolemy's Geography. Much of it will already be familiar to students, but it is very convenient to have the original texts and a guide to the secondary authorities in so accessible a form. One or two only of the author's conclusions can be mentioned here. He now believes that Ophir was on the African coast of the southern portion of the Red Sea. The concretions of earth and sea referred to in Pytheas' voyage he considers to be the "Watten" of the Frisian coast, and follows Nansen in locating "Thule" on the central Norwegian shore; Hanno's expedition is accepted as having reached Kamerun, and the Carthaginians are also credited with having reached the Azores. Considerable attention is given to the exploration of Northern Africa particularly in Roman times, and to relations between the Mediterranean and the Far East, in which the campaigns of Alexander were of outstanding importance. He agrees with some previous scholars in accepting Ptolemy's "Kattigara" as a forerunner of the mediaeval Quinsay.

The second volume illustrates the shrinking of the limits known to the peoples of Southern Europe which followed the breakdown of Roman organization. Africa scarcely figures at all in this period, and the sole development of importance was the discovery of America by the Norsemen. Dr. Hennig

interprets several extracts from the Icelandic chronicles as implying a more or less permanent settlement in North America during the twelfth century. His reasons are plausible, but one would like to know more of the reliability of the texts and of the problem of their interpretation before accepting his conclusion. This suggested colonization is however in Dr. Hennig's opinion not the earliest to be credited to the peoples of Western Europe, for he is an enthusiastic advocate of the location of the mysterious Hvitramannland (White Men's Land) or Great Ireland, mentioned in Icelandic chronicles, on the shores of North America. It is acknowledged that Irish monastic voyages, probably assisted by the Gulf Stream Drift, had visited Iceland before the Norsemen, but the probability that they continued their voyaging to America appears slight. The references to Hvitramannland do not completely exclude the possibility that they arose from a confused idea of Ireland.

If Europe was largely cut off from the Orient during this period, missionaries and travellers occasionally penetrated thither, *e.g.* the Nestorians, the sixth-century Cosmas Indicopleustes, and the Rabbi Benjamin of Tudela. The brief statement of William of Malmsbury that the ninth-century Anglo-Saxon bishop, Sigelmus, reached Southern India inspires less confidence. Dr. Hennig gives a concise account of the "Prester John" episode, accepting the genesis of the tradition in the momentary fame of the Kara-Kitai chieftain, Yeliutaschi, who defeated a Moslem army at Samarkand in 1141. The adventures of the Papal physician, Philippus, who was sent thirty-six years later with a letter to this potentate by Pope Alexander III, are, regrettably, unknown.

This brief note indicates what the compiler has attempted, and the fascination of the subject. The value of his work is not affected by the fact that final judgment must often be suspended. One small point of criticism may be permitted: as in most of these cases, our knowledge depends on the authority of later writers, it would be valuable to indicate clearly the dates of the latter, in addition to the dates assigned to the journeys or voyages. G. R. C.

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ENGELBERT KÄMPFER: der erste deutsche Forschungsreisende, 1651–1716. By KARL MEIER-LEMGO. (Herausgegeben vom Japan-Institut.) *Stuttgart: Strecker und Schröder*, 1937. 9½×6 *inches; 212 pages; illustrations. M.5 (unbound M.3.50)*

It is at first sight surprising that we have not had hitherto any adequate story of the life and work of the noted German scientific traveller of the late seventeenth century, Engelbert Kaempfer. This can be explained by the fact that most of the original material for such a Life has been buried in the British Museum MS. Department, and that the task of working through the mass of miscellaneous papers acquired after the traveller's death by Sir Hans Sloane was not to be lightly undertaken by any one not adept in deciphering the old German writing, sometimes almost illegible. It has at last been carried through by a countryman of Kaempfer, hailing from the very town in or near which most of the traveller's life was spent. The result proves that the work was well worth the doing.

For the extent and duration of his Asiatic travels (1683–93) Kaempfer takes a foremost place among scientific explorers, but his fame has rested mainly on but a small part of his work—his 'History of Japan,' which was long the standard authority on that country. The results of his previous eight years' researches (he spent two only in Japan) were never adequately set forth, for the unfavourable conditions of his home life after his return involved vexatious delays, and it was not till 1712 that an instalment saw the light under the title 'Amoenitates Exoticae.' In part a personal record, it embodied lengthy disquisitions on special subjects, and being written in Latin never attained wide popularity.

Only in 1933 was it first made more widely available in an abridged translation by the author of the present book. The more important work on Japan first came out, strangely enough, in English, through the action of Sir Hans Sloane, who had this section of the purchased MSS. translated by the young German, J. G. Scheuchzer. Not till 1777–79 was the German original published in the traveller's own country, though the English version had been translated into French, and this back into German in 1747–49. The original material drawn upon for the present work consists of extensive journals kept by the traveller, interspersed with many discussions of special topics; attractive drawings of buildings and other objects of interest, but especially of plants (for botany was his study *par excellence*); route-surveys and more finished maps; besides letters from and to the notable men with whom he formed friendships. These last, together with his commonplace book, still preserved at Detmold, are a valuable help towards the understanding of an interesting personality, and the whole sheds a valuable side-light on the state of the East in his time.

Kaempfer's thirst for knowledge was early excited, and he passed from one seat of learning to another, the range of his studies extending from Latin and other languages to medicine and the various branches of natural science, and even to music. Dr. Meier thinks that this was with a definite view to foreign travel. His opportunity came when he secured the appointment as Secretary to the Swedish Embassy of Fabricicus to Russia and Persia, and he made full use of the field for research so afforded. Ever looking farther afield he crossed Persia to Bandar Abbas, taking service as doctor under the Dutch East India Company, and after a wearisome detention there, pursuing his scientific labours undismayed by the intense heat, was at last able to see something of Southern India, Java, and Siam, before eventually finding his way to Japan. Hampered throughout by his official duties, and none too well treated by his employers, he continued to sieze every chance of scientific and historical inquiry, and one can only feel regret that the results of such untiring energy were never fully made known to the world. The return voyage was made by the tedious Cape route, but the record of it is unfortunately lost.

The story of his later life at home is somewhat distressing. His scant private means entailed the drudgery of a doctor's life, and he was ever chafing at the lack of opportunity to work out his material, while his unwise marriage with a girl less than a third his age was not conducive to happiness at home.

Dr. Meier seems to have undertaken his task as a labour of love, and the book is most readable. It is provided throughout with the requisite explanatory notes, and includes a judicious appraisement of Kaempfer's character and achievements. The illustrations are in part reproduced from the 'Amoenitates' and 'History of Japan,' in part more personal to the traveller himself. E. H.

ESMERALDO DE SITU ORBIS. By DUARTE PACHECO PEREIRA. Translated and edited by GEORGE H. T. KIMBLE. (Works issued by the Hakluyt Society. Second series. No. LXXIX. Issued for 1936.) *London*, 1937. 9×5½ *inches;* xxxvi+194 *pages; illustrations and maps*

Duarte Pacheco, who wrote the 'Esmeraldo,' was one of the captains who explored the west coast of Africa for John II, and after that Prince's death, for King Manuel. The latter, in 1498, sent him on a voyage westwards when he apparently sighted Brazil, which he visited two years later with Cabral. He served and fought in India, returning to Lisbon in 1505, and it was then that he was entrusted with the task of writing a detailed *roteiro* or pilot book for the information of shipmasters following the new sea-route to the East.

Unfortunately his manuscript was either mutilated in conformity with the Portuguese policy of secrecy, or it was never completed, for it breaks off at the Ilheo da Cruz, that is to say at the point reached prior to the voyage of Vasco da Gama. It appears that there were existing rutters up to this point, and it is just possible that Pacheco intended to make a more detailed examination of the newer section of the route before completing his text, but never had the opportunity. Moreover since the eighteenth century the maps and sketches of landmarks and harbours, which originally formed an integral part of the rutter, have been lost. Nevertheless incomplete though it is the 'Esmeraldo' is valuable as the only extant contemporary description of Africa as the Portuguese saw it in the opening years of the sixteenth century. It has the added interest of the introductory chapters on general cosmography, in which Pacheco gives his view of the general distribution of land and water at a date just prior to the discovery of the Pacific Ocean, and in which he makes a brief but acute contribution to the problem of the relation of skin colour to insolation. His prefaces to successive books contain summaries of the individual contributions of Prince Henry and his successors to the movement of Portuguese expansion, and he is in accord with modern scholarship in ascribing to the Infante the plan to conquer Guinea, it being left to John to make the decision to establish in San Thomé a base for the discovery of the sea-route to India.

The original manuscript having disappeared, the present translation has been made from a transcript, with assistance from two printed versions which appeared in 1892 and 1905 respectively. The editor, Mr. Kimble, has shown care and judgment in his introduction, appendices, and footnotes, and not the least valuable part of his work is the map of Africa in which the distances and bearings of the *roteiro* are plotted against a modern coast-line. The determination of latitudes was surprisingly good, and when allowance is made for the variation of the magnetic needle, the re-plotted coast-line is by no means grossly inaccurate. Two beautifully reproduced specimens of the illustrations which accompany the later *roteiro* of D. João de Castro (1541) give some idea of the treasure which was lost when the original of the 'Esmeraldo de Situ Orbis' disappeared. E. G. R. T.

## GENERAL

WESTWARD BOUND IN THE SCHOONER *YANKEE*. By Captain and Mrs. Irving Johnson. *London: Robert Hale & Co.*, 1937. 9½×6 *inches; 308 pages; illustrations and route-map.* 15*s*

This young American couple and their shipmates are entitled to congratulations on the accomplishment of a remarkable feat. Having purchased an erstwhile Dutch pilot schooner 90 feet long and manned her with a crew of fourteen, Captain and Mrs. Johnson made a world cruise from Gloucester, U.S.A., *via* the Panama Canal and islands of the Pacific to Bangkok, and thence to their home port round the Cape of Good Hope. The first half of the journey, which extended in all to eighteen months, was the more interesting to the travellers; and two-thirds of the book, which is written up in readable fashion by Mrs. Johnson, is devoted to its description.

Among the localities visited were the Galapagos Islands, Pitcairn, and the less-known Tonga islands. The party seem to have been well received in the various savage places at which they landed with the exception of Tucopia in the Solomon Islands, where, after an apparently friendly welcome, a sudden change of attitude on the part of the natives caused an abrupt return to the ship. In some places new islands and reefs were discovered; and an interesting journey

by air into the interior of British Guiana which some of the "Yankees" were privileged to make resulted in the discovery of new waterfalls and cascades.

From the point of view of the general reader some technical detail of navigation might have been omitted, and the account of fresh-water baths provided by a British man-of-war, described on p. 288, is likely to be read by British naval officers with mingled feelings. The illustrations are suitable to the experiences of the travellers and to the general object of the book. W. G. G.

A HISTORY OF THE MERCHANT NAVY. By H. MOYSE-BARTLETT. *London: George G. Harrap & Co.*, 1937. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 302 *pages; illustrations and maps.* 7*s* 6*d*

Mr. H. Moyse-Bartlett has written an interesting book on this subject, but it deals more with the exploratory work than with the actual work of a mercantile ship. In spite of the many books written (not by seamen) on this subject we still turn to Lindsay for the best information. But Lindsay and Sir Archibald Hurd have written at length, and the advantage of this book is that it is on a small scale and full of interesting matter; more interesting perhaps from a geographer's point of view than from that of a seaman.

The illustrations are good. It is a great pity that a picture of Green's *Challenger* cannot be discovered, for her building marked an important epoch in British naval architecture.

The accounts of the nautical instruments, charts and the progress of ship building are quite interesting and well supported by illustrations drawn from the Science Museum. The Chinese compass facing p. 33 is a Japanese one.

The book is to be commended to geographers and sailors as including in a small compass a good general account of sea work, and it is completed with a bibliography and written in an easy manner. D. W. B.

THE GATEWAY: pen-pictures from Gibraltar and southern Spain. By WYNDHAM DISNEY-ROEBUCK. *London: Heath Cranton.* 1937. $7\frac{1}{2} \times 4\frac{1}{2}$ *inches;* 160 *pages; illustrations* (by Betty Disney-Roebuck). 3*s* 6*d*

ACROSS THE MEDITERRANEAN. By MARY BERENSON. *London: Constable & Co.*, 1937. $9 \times 6$ *inches;* xiv + 164 *pages; illustrations and route-map.* 7*s* 6*d*

Those who have at any time lived in Gibraltar will welcome the assembling in book form of these few sketches by a former editor of the *Gibraltar Chronicle*. War was indirectly responsible for them, for they date from 1917–18, but it has left scant traces of its presence. The author has an observant eye, a sense of humour, and was blessed with a wish to penetrate below the surface of life on the Rock and in southern Spain. He was a keen follower of the Royal Calpe, but he was equally stirred by the garden of Lindaraja, or a square in the Albaicín. Perhaps the picture of peasant life in Andalusia is too idyllic. One wonders whether, in the days of the Second Republic, bull fighting was still so popular.

Mrs. Berenson went beyond the Rock, and many who have never set foot in North Africa will enjoy her account of Tunis and Algiers, not only because of what she saw—and she visited most of the famous archaeological sites—but for her method of approaching travel as a whole. The joy of it for her lies more in the memories than in the actual experience, in the visions that came back to her mind afterward and untrammelled by the minor vexations of life. She makes light of her own knowledge, and would pass herself off as the wife of a distinguished art critic, until some revealing passage—a description of Matmata, or her feeling for the spirit of an ancient building such as the amphitheatre at El Djem—shows her true and observant self. J. P. H. M.

# THE MONTHLY RECORD

## AN INTERESTING JUBILEE

At the beginning of September 1887, Lieut. F. E. Younghusband, then a subaltern in the King's Dragoon Guards, reached Yarkand after a four months' journey from Peking. He proposed to return to India by the usual route across the Karakoram Pass to Leh, but at Yarkand he found a letter awaiting him from Col. Bell, then crossing the Karakoram pass. This suggested that instead of following him over this route, Younghusband should attempt the more direct but unexplored route across the Muztagh range to Baltistan and Kashmir, to ascertain if it was still in use, and what its commercial and military value was. Younghusband was delighted at this suggestion, for the route promised to be "difficult enough to be really worth doing," and he set about his preparations with a will.

It was said that in former years a little trade had been carried on across the Muztagh Pass with Baltistan, but the raids of Kanjut robbers and the worsening of conditions on the pass had interrupted this traffic. He was however able to engage a native of Askole, named Wali, who believed that he could recall the route he had travelled twenty-five years earlier. The sole condition he made was "that I should not look at a map." Thirteen ponies were obtained, and three other Baltis and four Ladakhis engaged, the equipment including "some good strong ropes and a pickaxe or two."

The party left Yarkand on September 8, and marching by Kargalik and Kokyar, crossed the Kuen Lun by the Chiraghsaldi pass some eight days later, and reached the Yarkand river at Chiraghsaldi camping-ground. Progress down the river was much impeded by the gorges, through one of which they were obliged to build a pathway. The route then struck southwards, up a small tributary, to the Aghil pass. From the head of the pass, Younghusband obtained an extensive view of the Karakoram mountains; this was the first time that this portion had been seen from the north by a European. "Before me," he wrote, "rose tier after tier of stately mountains, among the highest in the world—peaks of untainted snow, whose summits reached to heights of twenty-five thousand, twenty-six thousand, and in one supreme case, twenty-eight thousand feet above sea-level. There was this wonderful array of mountain majesty set out before me across a deep rock-bound valley, and away in the distance, filling up the head of this, could be seen a vast glacier, the outpourings of the mountain masses which give it birth."

It had previously been supposed that the southern tributaries of the Yarkand ran down directly from the Muztagh range, but it was now apparent that a subsidiary range was interposed between the Kuen Lun and the Muztagh, which Younghusband was now crossing for the first time.

From the head of the Aghil pass, a cliff of some 200 feet descended to a river. This was successfully negotiated by following the tracks of *kyang* (wild asses). The Baltis called this river, a tributary of the Yarkand, the Shaksgam. The next day they reached downstream a tributary, the Sarpo Laggo, which they ascended, bivouacking at its exit from the glacier coming down from the Muztagh pass. The difficulties of their task became apparent; and for three days they struggled up the broken surface of the glacier. Younghusband then decided to send the ponies round by Shahidula and the usual trade route to Kashmir, while he and a small party attempted to cross the Muztagh to Askole. On September 28, they arrived at the head of the pass, to find a precipitous ice-slope before them. The party then roped themselves together, and led by Wali with

a pickaxe began the descent. After six hours, despite lack of mountaineering experience or adequate equipment, they reached the glacier at the foot of the pass. The main obstacle to their progress had now been overcome, and the journey through Baltistan and Kashmir was uneventful. He finally reached Rawalpindi on November 4, seven months after leaving Peking.

It is thus fifty years since Younghusband crossed the Aghil and Muztagh passes, the first European to do so. The former was crossed by Capt. Grombchevski two years later on a journey from the Shaksgam to the Yarkand valley, and two parties have climbed the Muztagh pass. This year an expedition led by Mr. E. E. Shipton, accompanied by H. W. Tilman, J. B. Auden, and M. A. Spender, has penetrated to the Shaksgam area, and we may hope that after a lapse of fifty years to the month, the Aghil pass has again been visited.

To mark the jubilee of his achievement, we understand that Sir Francis Younghusband has prepared a new edition of his 'Heart of a Continent,' in which this journey is described. It is to be published by John Murray this autumn.

## INTERNATIONAL GEOGRAPHICAL CONGRESS, AMSTERDAM, 1938

The fifteenth International Geographical Congress will be held, under the auspices of the International Geographical Union, at Amsterdam in the second half of July 1938. The organization of the Congress is in the hands of an executive committee, of which Professor Dr. J. P. Kleiweg de Zwaan is President, and Mr. E. J. Voûte Secretary. Any person interested in geography can attend as a member of the Congress, and it is only necessary to fill in the form distributed by the Executive Committee and send it to the Secretariat of the Congress, and to pay at the same time the registration fee of 12 florins 50 (at the present rate of exchange about 9 florins go to the pound). Relatives of members and students of geography recommended by their professors may be registered at a reduced fee of 5 florins for each person. It would greatly assist the Executive Committee if those desirous of being registered as members would communicate at once with the Secretariat, Koloniaal Instituut, Mauritskade 63, Amsterdam. Subjects for discussion include the six questions which have been considered by commissions appointed by the General Assembly of the International Geographical Union at Warsaw, 1934; that is, population and "habitat rural"; pliocene and pleistocene terraces; climatic variations; publication of old maps; aerial photography; and the cartography of tertiary erosion surfaces. The Executive Committee propose also twenty-eight subjects for discussion in the six sections. Those who wish to take part are requested to submit their contributions before 1 January 1938. One excursion has been arranged to precede the Congress, and five to follow it. A tour to the Dutch East Indies will leave Amsterdam at the beginning of August. The numbers on these excursions are limited, and those proposing to take part should inform the Secretariat as soon as possible.

## SEARCH FOR OIL IN GREAT BRITAIN

In the *Quarterly Journal* of the Geological Society for June, Messrs. G. M. Lees and P. T. Cox discuss the geological basis of the D'Arcy Exploration Company's search for oil in Great Britain, and indicate the general results so far obtained. Four areas have shown prospects, some of which are up to the standard of the average oil exploration; the Lower Carboniferous oil shale series in Scotland, where among frequent shows in the well was one of 1700 gallons; the Permian of north-eastern Yorkshire, which it is proposed

to test by a bore-hole at Aislaby; the Carboniferous of midland and eastern England, the most prolific seepages in England being in the Coal Measures; and the Jurassic and Lower Cretaceous of southern England, with indications in the Purbeck beds of Dorset and outcrops in Sussex, and in the Wealden beds. In the latter area two bore-holes were put down at Portsdown and Henfield, on account of the favourable character of the anticlines and in the hope that the whole range of oil-bearing horizons would be found. The first was drilled to a depth of 6556 feet, the second to 5105 feet; potential reservoir rocks however were not present, and no oil or gas shows of commercial importance were encountered. Despite this result, the prospects of the Jurassic of southern England are not affected, and it is proposed to drill the Kingsclere anticline in north Hampshire and the Poxwell fold in Dorset. East of the Trent, geophysical surveys are being carried out over a wide area to determine whether Carboniferous structures which could hold an oil accumulation are present below the Permian and Mesozoic rocks of Lincolnshire.

## THREATENED CAPTURE OF THE UPPER LOGONE

General Tilho has frequently drawn attention to the probability that the upper course of the Logone will be captured by the Benoué system, with disastrous effects upon its lower course and Lake Chad. In 1935 he was charged with a mission to investigate this problem, and a preliminary outline of his conclusions are published in *L'Afrique française* for May 1937. Though it is not of course possible to estimate when this capture is likely to occur, the existing situation has sufficient inconveniences to justify remedial action. The danger point is close to the village of Eré, at the junction with the Tandjilé. Here the course of the Logone has been progressively deflected to the west, forming a well-marked bend in its general north-westerly direction. The writer believes that this deflection amounts to about 3 metres a year. On this portion of the river, its left bank has been breached in seventeen places, through which water escapes when the river is 2·8 metres above low-water mark. The immediate banks of the river are higher than the land to the west, which forms an extensive marshy tract known to the natives as Lake Boro, and is linked to the depression of Toubouri by the Kabia. It is through these depressions that the flood waters of the Logone escape to the Benoué. This partial capture has resulted from the scouring of the left bank to a depth of 1·5 metres; a reduction of this level by a further 3 metres would make the capture complete. Above Eré, the slope of the river is 1 in 5000, that of the depression is 1 : 2500, while downstream it is only 1 : 6000. For this reason the bed is becoming silted up, a tendency which contributes to the escape of water into Lake Boro. The effect of this upon the water supply of Lake Chad must be considerable; in 1935 for example the flood waters of the Logone above the "depression of capture" was over 1 metre higher than in 1934, while below this point it was 1 metre lower. The water thus deflected caused destructive floods in the western depressions. This diversion begins when the flood is about 2·8 metres above low water; in 1935 it rose 4·3 metres. General Tilho suggests that to prevent diversion it would be possible to extend the period of flood water, and so reduce its height, by building retaining dams on the four headwater streams of the Logone.

## NATIVE AGRICULTURE IN DAR-ES-SALAAM

In the *Tanganyika Notes and Records*, April 1937, Messrs. A. V. Hartnoll and N. R. F. Couchman describe the system of agriculture practised in the central hill area of the Dar-es-Salaam district. The soils on these hills vary from a deep red loam to a heavy black clay. The original covering of these hills

was a dense deciduous scrub forest, known as *vichaka*. This area is of great importance to the natives, as it contrasts strongly in fertility with the soils of their lowland villages, and produces their grain and cash crops. They practise shifting cultivation, which has removed much of the *vichaka*. The fertility of the soil is restored periodically by allowing the land to revert to a secondary scrub forest, known as *mashokora*, from which this system of cultivation takes its name. A definite succession of crops is carried out. In the first year rice is grown, when the leafy humus holds the necessary moisture. The bush is cut and carefully burnt, leaving a belt of uncleared forest, so that the *mashokora* can re-establish itself when required. In the second year, if the land is particularly good, rice is sown again with sorghum, if not the latter is sown alone. The crops of the third season are also determined by the quality of the soil, sorghums or maize and cassava. The fourth year cassava is planted, and the area then rapidly reverts to *mashokora*. This bush is rarely cleared again before it is ten years old, and unless it has been left for twenty years, the land is not considered fit for rice cultivation.

The writers suggest that the system might be improved by the introduction of cotton as a subsidiary cash crop, a larger area being cleared for rice and cotton being planted with sorghum in the second and third years. When pressure on the land increases, it will be necessary to grow more leguminous crops for green manure. The clearing of the bush should remove the tsetse, permitting the use of cattle for ploughing. When it becomes no longer possible to restore the cover periodically, measures to prevent soil erosion will be necessary.

Viewed administratively, the *mashokora* system has several advantages. The ridges are particularly suitable for good roads, which would encourage the movement of population into the higher, healthier areas instead of concentrating round large centres like Dar-es-Salaam. The only additional requirement is the provision of wells, owing to lack of permanent water supplies. There is still much land available for this cultivation, before more scientific methods have to be adopted.

## A GAZETTEER OF HAWAII

We have recently received from Professor J. W. Coulter a copy of a 'Gazetteer of the Territory of Hawaii' (Honolulu, 1935), compiled under his direction. This contains all place-names that have appeared on published maps. The names on the maps produced by the United States Geological Survey form the basis of the work. Names from an earlier set of maps, deriving from the Hawaiian Government surveys, and from the U.S. Coast and Geodetic charts, have been added, and finally names from miscellaneous maps. The latitude and longitude of all features included are given. There are cross-references from early spellings to the present forms, where these can be identified: otherwise the early form is entered with the position as indicated on the original map. The names are grouped by islands, each group being accompanied by a sketch-map of the island on which approximate positions can readily be found.

As a result of its history, the nomenclature of the Territory of Hawaii is almost entirely Polynesian. As the natives did not use an appended name for streams, there are a number of hybrid names obtained from the native name with "river," "gulch," "creek," etc., added. No doubt it would be possible to remove most of the foreign names. The list does not attempt to decide upon the correct names where these differ in the original sources, or spellings. It seems probable however that the U.S. Geological Survey forms will ultimately become adopted, though these sometimes differ from the Coast and Geodetic charts, and the U.S. Geographic Board. The Coast and Geodetic Survey omit *Puu*,

peak or hill, from names, though it is inserted by the Geological Survey. The gazetteer is useful in bringing all these forms together, and in enabling the modern forms of the early narratives to be determined. It should serve as a basis for standardization in the future. Useful notes on Hawaiian nomenclature and systems of land division have been added, also a list of Hawaiian names for topographical features.

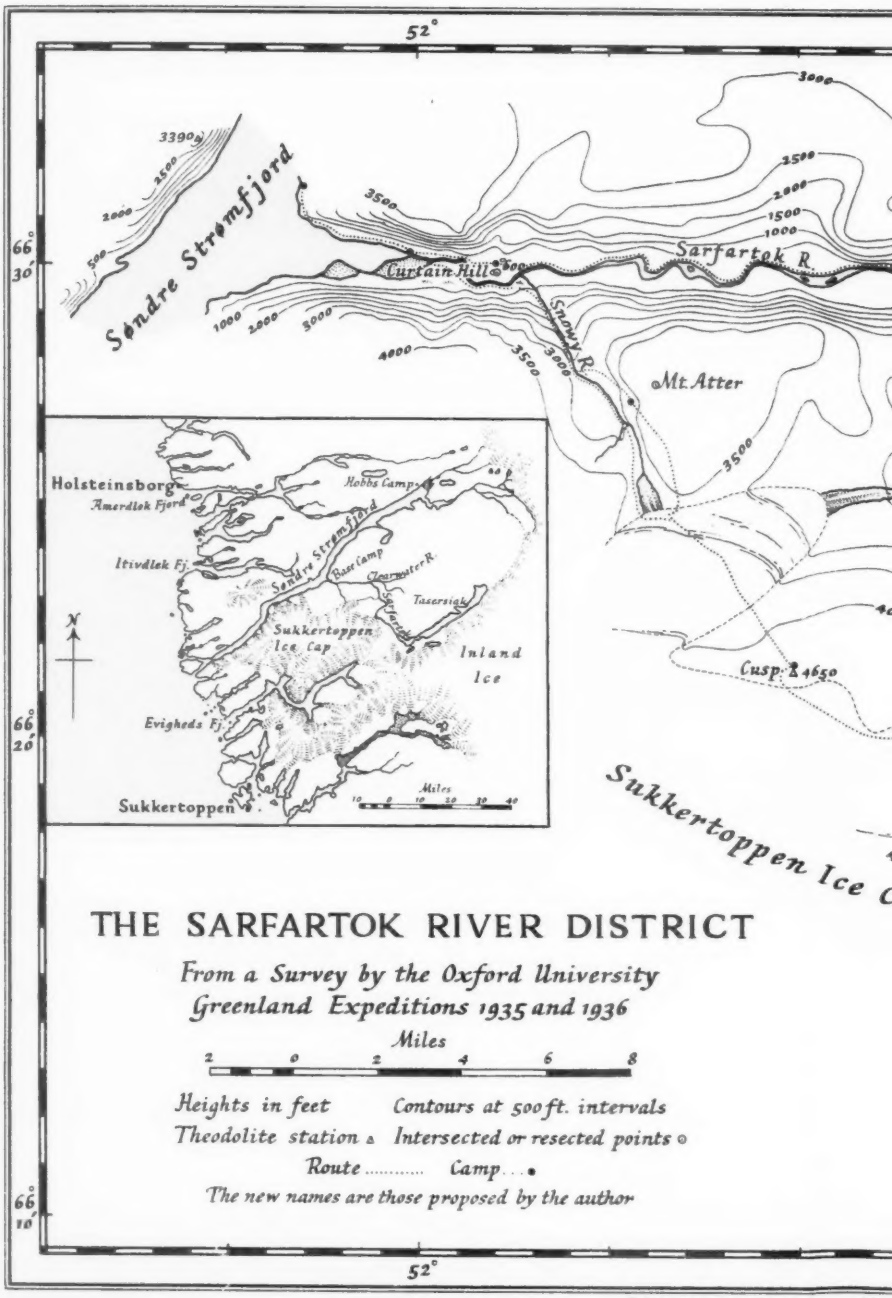
## OBITUARY

### MRS. ELEANOR ELKINS RICE

We record with very great regret the death of a good friend and most generous benefactor to the Society. Mrs. Hamilton Rice, widowed in the loss of the *Titanic*, married our Gold Medallist in 1915, and from that year devoted much of her time and her fortune to those enterprises in which her husband is so greatly distinguished, the exploration of the northern affluents of the Amazon, and the promotion of geographical research. Their journeys to the Rio Negro and the Rio Branco in 1919 and 1924 rank high for their perfection of plan, equipment, and achievement.

Mrs. Rice joined our Society in 1921, and nearly every year since the war she and her husband had dined at the Annual Dinner. When the time came to raise a fund to complete the Society's House in celebration of its centenary, the gift of Dr. and Mrs. Hamilton Rice was the first and largest contribution to the fund; and happily they were present to cut the first sod for the foundations of the new building in the early summer of 1929. The Institute of Geographical Exploration which they have since given to Harvard is a noble endowment to our science.

Their many friends in England will mourn the loss of a great-hearted, courageous, and generous lady, and will extend their profound sympathy to Dr. Hamilton Rice.




# THE SARFARTOK RIVER DISTRICT

*From a Survey by the Oxford University Greenland Expeditions 1935 and 1936*

Miles

2 0 2 4 6 8

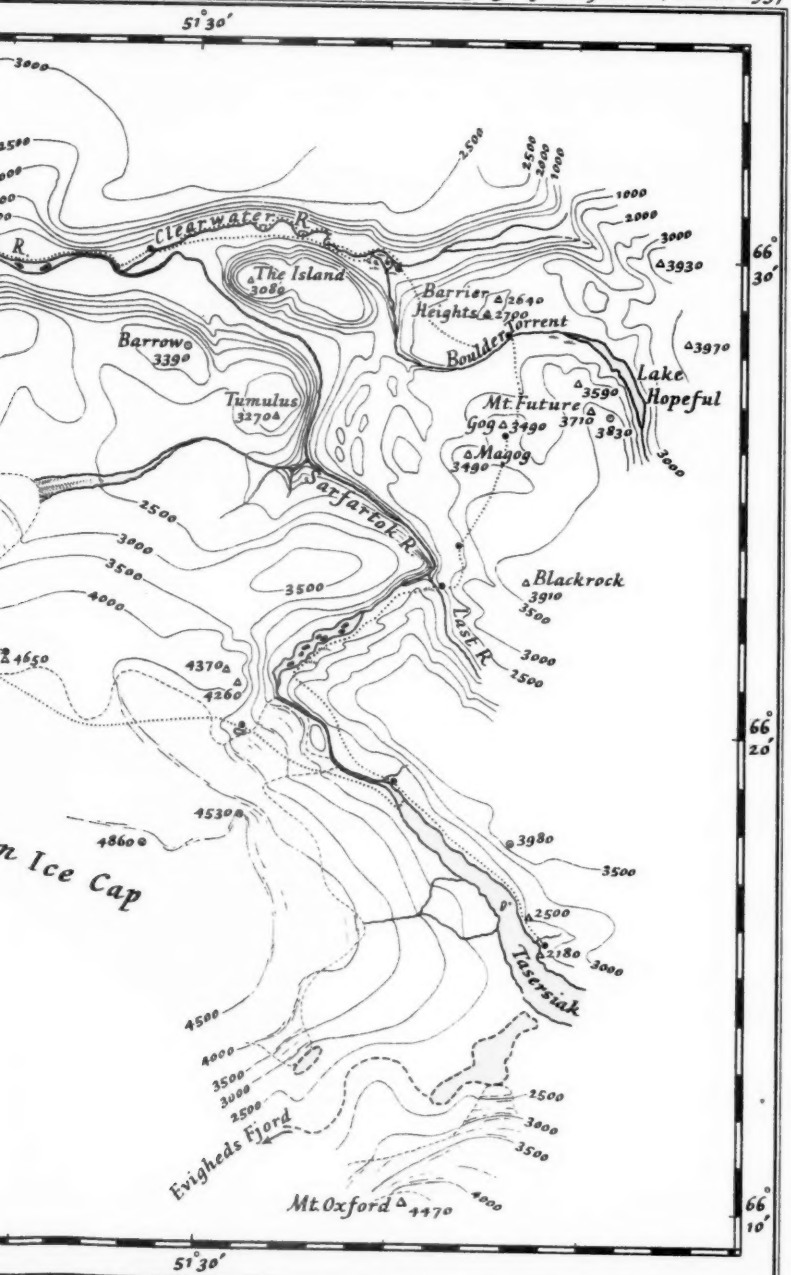
*Heights in feet* *Contours at 500 ft. intervals*

*Theodolite station* △ *Intersected or resected points* ⊙

*Route* ..... *Camp* . . . •

*The new names are those proposed by the author*

*Published by the Royal Geographica*

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